

TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

FORTY-NINTH ANNUAL REPORT 1936



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*In cooperation with U. S. Department of Agriculture.

†On leave of absence.

‡As of August 15, 1937

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*In cooperation with U. S. Department of Agriculture.

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FORTY-NINTH ANNUAL REPORT, 1936

A. B. CONNER, Director

The Agricultural Experiment Station, comprising the main station at College Station and sixteen substations and six field laboratories serving different agricultural regions of the State, is the agricultural research division of the Agricultural and Mechanical College of Texas.

As a result of a ten-year breeding program, seed of four new varieties of yellow corn have been made available to Texas farmers who wish to replace their old white varieties with yellow corn of high vitamin potency: **Golden June**, adapted to the western half of the State west of the 30-inch rainfall line, and, for late planting, in all parts of Texas as well as in parts of Louisiana, Arkansas, and Oklahoma; **Yellow Surcropper**, a high producing variety in every part of the State, and particularly suitable for planting in the less fertile soils; **Yellow Tuxpan**, suitable for the irrigated areas of south and southwest Texas and the heavy blackland of the Gulf Coast region of Texas and Louisiana, as well as the Everglades of Florida; and **Golden Thomas**, suitable for the corn growing region of southwest Texas in the vicinity of Beeville and San Antonio on the non-irrigated lands. These new varieties were developed by careful breeding methods involving cross-pollination and are of particular importance because of the fact that until the yellow color was bred into popular varieties of white corn there were no varieties of yellow corn available in the State that would yield as well as white corn except on the fertile soils of central Texas.

Progress has been made during the year in securing, by individual selection, strains of milo possessing resistance to a disease which either kills the plants outright or causes a stunted condition of growth in the early stages. This disease has caused severe losses to the milo crop in certain areas of Texas during the past several years. Many of the selections developed thus far, when grown experimentally in comparison with common strains, have shown 100 per cent resistance to this disease. Field test plantings are being made in the hope of determining under field conditions the reliability of these strains for general use in infested areas to replace the common susceptible milo grown throughout the State at present.

Through the preparation of a peach zone map, the Texas Station has defined the region of the State with sufficient cold to enable the production of a normal crop of commercial varieties of peaches every year; the region with sufficient cold to produce a normal crop 90 to 100 per cent of the time; the region with sufficient cold to produce a crop 80 per cent of the time; and the regions where a normal crop may be expected less than 80 per cent of the time. Cold weather, the traditional enemy of a good peach crop, is an enemy only if the cold comes too late. Contrary

to common belief, commercial varieties of peaches require a certain amount of cold weather in order to blossom and set normally for the production of a good crop. By comparing weather records over a number of years with the peach crop produced during the period, workers have estimated that around 800 hours of temperature below 45 degrees F. is required for a normal crop of commercial varieties of peaches. The only means of avoiding losses in regions with a low proportion of cold weather is to plant varieties that require little or no cold weather. At present this means varieties of the honey type. The Division of Horticulture has made a number of crosses between honey and commercial varieties of peaches in the hope of securing new varieties that will combine the advantages of the present commercial varieties with ability to bloom and set fruit normally in regions having a limited amount of cold weather.

Investigations of rose diseases, including laboratory tests at College Station and field work at the Tyler station, covering three seasons of work have during the year developed information concerning five of the important diseases attacking rose plants in Texas, and partial control has been worked out for two of these diseases, namely, die-back and black-spot. Die-back is a fungus disease in which infection apparently occurs only through open flowers. Accordingly the most effective control is to prune off the flowers soon after they are fully opened. Field control of black-spot has been secured by the use of different coppers and sulphurs. The time of application has been found to be an important factor in control. Whereas dusting was formerly done only in the spring, recent results indicate that dusting should be done in September and October as well. Because of the increasing importance of the rose industry in Texas, investigations will be pursued vigorously, both in the hope of developing methods of control of the disease affecting the rose plant and also of developing strains resistant to disease.

The Texas Station has developed, in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture, new strains of wheat which are more resistant to both leaf and stem rust than any hitherto available. These strains are making very promising yields in preliminary trials under severe rust conditions in south Texas. Progress is also being made in the development of rust-resistant oats. This development is significant particularly in that it promises to extend the possibility of small grain production in the southern region, not only for grain but also for use as a grazing crop in connection with live-stock production.

In the Division of Farm and Ranch Economics, investigations during the year concerning the cost and services of local government in Texas, involving an analysis of expenditures for 1933 in 38 representative rural counties ranging in population from 2,197 to 77,000, have indicated

that consolidation of smaller counties would produce substantial savings. Work in cooperation with the United States Department of Agriculture has also been continued during the year in the assembling and analysis of experimental, economic, and statistical data relating to Texas agriculture on a county and type-of-farming basis to provide a description of agriculture of each area in relation to its physical resources. It is believed that the analysis and interpretation of these data will greatly facilitate the planning and administration of agricultural adjustment programs.

Recent experiments conducted by the Texas Station have shown that the weathering of cotton in the field due to delays in harvesting results in considerably more damage to the fiber than has generally been thought to be the case. This work has a significant relation to the mechanical harvesting of cotton for the reason that the delayed harvesting necessary in order to make mechanical harvesting successful may result in losses that are greater than the gains which may be expected from the less expensive machine harvesting.

The Agricultural and Mechanical College of Texas was requested to prepare material for the Texas Centennial Exposition at Dallas as a part of the Story of Life exhibit of the United States Public Health Service in the Federal Building. Several divisions of the Station prepared and contributed material on the following subjects for this exhibit: Story of the Texas Fever Tick; Diseases Affecting Man and Animals, and Comparative Anatomy; Texas Mammals, Prehistoric; The Story of Vitamins; and Plant Diseases. The exhibit was made up of groups of items, including photographic transparencies, enlargements, legends, charts, and specimens, and the material prepared by this Station made a very creditable addition to the United States Public Health Service exhibit as a whole. The United States Public Health Service has published a pamphlet describing these exhibits in detail.

These are but a few of the more outstanding results of research during the year. Significant progress has been made in many other fields and is discussed in detail in the following pages. During the year sixteen bulletins, three circulars, and twenty-nine scientific articles reporting these and other results of research have been published and distributed to farmers and other interested individuals, to libraries, and to agencies engaged in the dissemination of reliable agricultural information.

ORGANIZATION AND WORK

The Agricultural Experiment Station System comprises the Main Station with twenty divisions at College Station, sixteen substations in the several agricultural regions of the State, and six field laboratories, as follows:

Divisions

Administrative	Botany
Veterinary Science	Swine Husbandry
Chemistry	Dairy Husbandry
Horticulture	Poultry Husbandry
Range Animal Husbandry	Rural Home Research
Entomology	Apiculture
Agronomy	Feed Control Service
Plant Pathology and Physiology	Agricultural Engineering
Farm and Ranch Economics	Wildlife Research
Soil Survey	Publications

Substations

No. 1, Beeville, Bee County	No. 9, Balmorhea, Reeves County
No. 2, Tyler, Smith County	No. 10, College Station, Brazos County
East Texas Soil Erosion Station	No. 11, Nacogdoches, Nacogdoches County
No. 3, Angleton, Brazoria County	No. 12, Chillicothe, Hardeman County
No. 4, Beaumont, Jefferson County	No. 14, Sonora, Sutton-Edwards Counties
No. 5, Temple, Bell County	No. 15, Weslaco, Hidalgo County
Blackland Soil Erosion Station	No. 16, Iowa Park, Wichita County
No. 6, Denton, Denton County	No. 19, Winter Haven, Dimmit County
No. 7, Spur, Dickens County	
No. 8, Lubbock, Lubbock County	

Field Laboratories

Apicultural Research Laboratory, San Antonio, Bexar County.
 Truck Crop Insect Investigations Laboratory, Dickinson, Galveston County.
 Cotton Insect Laboratory, Presidio County.
 Loco Weed Laboratory, Alpine, Brewster County.
 East Texas Pasture Investigations Laboratory, Lufkin, Angelina County.
 Tomato Disease Laboratory, Jacksonville, Cherokee County.

Station Lands

The following table shows the lands owned and operated for agricultural research by the Agricultural Experiment Station of the Agricultural and Mechanical College of Texas:

	Acres of Land Devoted to Various Uses			
	Area	Culti- vated	Pasture	Farmstead Roadways and Mis- cellaneous
Total.....	7803.59	2117.32	5403.43	282.54
Main Station (Agronomy) Farm.....	*92.00	64.00	12.00	16.00
Horticultural Farm.....	*50.00	18.00	12.00	20.00
Veterinary Science:				
Main Station Laboratory.....	*141.00	5.00	130.00	6.00
Loco Weed Laboratory (Brewster County).....	**1.00		1.00	
Entomology:				
Truck Crop Insect Investigations (Galveston County).....	**20.00	15.00	1.50	3.50
Cotton Insect Laboratory (Presidio County).....	**1.00			1.00
Range Animal Husbandry:				
Cattle Feeding Investigations (Howard Co.).....	**80.00		80.00	
Apicultural Research Laboratory (Bexar Co.).....	10.00	4.50	4.50	1.00
Substations:				
No. 1. Beeville.....	151.50	112.00	25.00	14.50
No. 2. Tyler.....	285.20	30.00	240.20	15.00
E. Texas Soil Erosion Station.....	170.00	170.00		
No. 3. Angleton.....	159.30	78.00	78.00	3.30
No. 4. Beaumont.....	100.00	73.00	3.00	24.00
No. 5. Temple.....	†126.13	122.00		4.13
Blackland Soil Erosion Station.....	**139.30	138.30		1.00
No. 6. Denton.....	209.92	139.00	54.00	16.92
No. 7. Spur.....	413.92	293.57	110.35	10.00
No. 8. Lubbock.....	160.00	140.00	10.00	10.00
No. 9. Balmorhea.....	200.00	80.00	110.00	10.00
No. 10. College Station.....	‡920.80	150.00	719.00	51.80
No. 11. Nacogdoches.....	81.60	35.40	36.00	10.20
East Texas Pasture Investigations (Angelina County).....	**275.50	50.00	223.50	2.00
No. 12. Chillicothe.....	100.00	85.00	5.00	10.00
No. 14. Sonora.....	3461.63	59.93	3390.70	11.00
No. 15. Weslaco.....	100.00	79.92	2.68	17.40
No. 16. Iowa Park.....	161.79	105.00	40.00	16.79
No. 19. Winterhaven.....	192.00	70.00	115.00	7.00

*Included in the main tract of College land.

**Leased land.

†Includes 32 acres of leased land.

‡Includes 655.12 acres of main tract of College land.

VETERINARY SCIENCE

Loin Disease in Cattle

The bacteriology of loin disease is still under investigation. As reported last year this work has been greatly impeded by reason of loss of toxicity of our cultures at certain times which necessitated retracing of steps. We now believe that the reason for this loss of toxicity was due to too great a change in pH of the media during sterilization.

H. Schmidt.

Soremouth in Kids and Lambs

Experiments on this project were conducted at the Sonora Station.

H. Schmidt.

Infectious Bovine Abortion

The investigations on Infectious Bovine Abortion were continued. The infected dairy herd at the Feeding and Breeding Station has been practically eliminated by sale of all cows. Only a few remain to be sold. Of the 17 cows calving during the year one aborted. This abortion was due to Bang's disease. The 17 conceptions required 29 services, or an average of 1.7 services per conception. Of these, nine cows conceived after one service, six after two services, one after three services and one after five services.

In the clean herd of the Feeding and Breeding Station dairy, 48 cows calved during the year. These 48 conceptions required an average of 1.33 services per conception. Thirty-eight cows conceived after one service, five after two services, four after three services, and one after four services. One cow aborted in this herd 194 days after conception. No Bang organisms could be recovered from the foetus and the agglutination test on the cow remained negative.

The college dairy herd remains free from Bang's disease as far as the agglutination test can be relied upon. During the past year four additional abortions occurred in this herd, and in each case trichomonads were found. In addition the genital organs of all bulls in service in this herd revealed a condition described in the literature as typical of trichomonad infection. This probably explains the six abortions occurring in the latter part of last year on the basis of trichomonad infection.

H. Schmidt.

Swellhead of Sheep and Goats

The veterinary staff at the Main Station has not had occasion to investigate additional outbreaks of this disease during the year. It is now recognized that a number of plants can produce swellhead under certain conditions; one of these plants is lechuguilla (*Agave lecheguilla*). The precise nature of the toxic principle in lechuguilla poisoning has been under investigation by Dr. Frank P. Mathews at the Alpine Station, who chose this subject for his thesis for the degree of Doctor of Philosophy. His findings are to the effect that lechuguilla contains two toxic principles. One of these is a toxic photodynamic agent which causes a swelled head when the animals have partaken of the plant and at the same time are exposed to sunlight. The other toxic principle contained in lechuguilla is apparently a saponin and causes pathological changes in the kidneys and liver. Both toxic principles appear to be separate and distinct chemical substances. A manuscript covering this phase of the work has been submitted for publication as a bulletin.

H. Schmidt.

Stomach Worms in Sheep and Goats

No active experimental work was carried on at the Main Station laboratory on stomach worms in sheep and goats during the past year.

In its place attention was given to *Trichostrongyles* in sheep and goats. These parasites have become quite prevalent and quite destructive in these animals, especially in goats in some regions of the State. A number of drugs were tried, but none of them proved effective in combating this parasite.

H. Schmidt.

Swamp Fever in Horses and Mules

Work on this project has been suspended on account of lack of material but will be resumed when conditions and facilities permit.

H. Schmidt.

Anaplasmosis

It was reported last year that three outbreaks of this disease had been found in the State. During the year elapsing since our last report three more outbreaks were observed, and in all three heavy losses in cattle were experienced. In each instance the outbreaks were found in areas in which the Texas fever tick had been eradicated and the area released from quarantine. So serious have these losses become that the Division has undertaken a new project with Anaplasmosis, to be begun within the next thirty days.

The Division of Veterinary Science has in the past inoculated a large number of animals against Texas Fever at its Texas Fever Barns. In this work Anaplasmosis always appeared as a mixed infection with Piroplasmosis. During the last year, however, a pure strain of *Anaplasma marginale* was obtained from a cow that has never had ticks on her but was inoculated from a ticky cow in June, 1931. At that time she showed both *Anaplasma* and *Piroplasma* in the blood. Inoculation of her blood into susceptible animals five years and three months later showed that she no longer carried the *Piroplasma*, but was still a carrier of *Anaplasma*. This test was run on 53 susceptible two-year-old animals, all of which later had a severe reaction of *Piroplasma* when again inoculated with blood carrying this organism, thus proving that they were susceptible to Piroplasmosis at the first inoculation.

H. Schmidt.

Loco Weed Poisoning

Work on this project was temporarily suspended on account of lack of plant material but will again be resumed when conditions permit.

F. P. Mathews.

Miscellaneous Poisonous Plants

The investigation of *Sartwellia flaveria* as a probable cause of hepatic cirrhosis in goats was continued. The method of feeding the plant was varied from that previously employed so as to give smaller doses

over a longer period of time. In order to accomplish this the feeding had to be interrupted to permit the animal to regain its appetite. With this method a condition of the liver has been reproduced in goats that closely resembles that found on the range. Whether or not the two conditions are identical needs further investigation.

Broomweed (*Gutierrezia microcephala*), long suspected of causing abortion in cattle, was fed to one pregnant cow at the rate of 0.8 lb. of green plant daily from December 1 to 21, and 0.9 lb. from December 22 to April 1. On April 24 the cow delivered a healthy calf. The amount of dry plant fed per day is equivalent to about 3.6 lbs. of green plant. This is the second experiment tried, both of which were negative.

In an attempt to clear up sudden and serious losses of cattle on a certain range *croton corymbulosus* was fed to one calf in the amount of 0.4 and 1.4 lbs. of this plant on consecutive days, without ill effects. Nine days later it was fed 1.5 lbs. daily of this plant on three consecutive days. A blood-stained diarrhea resulted but there is no history of this symptom in the animals that died on the range.

F. P. Mathews.

Hard Yellow Livers in Cattle

There has been no recurrence of this condition in any of the ranges previously affected. Feeding of a certain suspected plant is, however, being carried on at Substation No. 14, Sonora, where a report on this condition will be found.

H. Schmidt.

Sheep Losses in the Feed Lot

No losses among sheep in the feed lots in Texas were brought to the attention of the Division of Veterinary Science during the year. Work on the mold cultures on hand and previously reported on were continued, in which the same method of administration as in the previous year was used and also the same cultures. This year the molds were grown on ground hegari heads. This medium was used because the sheep among which the original losses occurred were being fed hegari. None of the sheep showed ill effects from the huge doses of molds thus received.

H. Schmidt.

Chronic Nephritis in Cattle and Sheep

This disease has again been prevalent in a restricted area in the central part of the State and again caused heavy losses. No additional information as to the probable cause of the trouble has been developed during the year.

H. Schmidt.

Jimmies in Sheep and Goats

An attempt to prevent "Jimmies" under field conditions by feeding sheep on different mineral mixtures was started on November 28 and

discontinued on April 2. In this test 100 sheep were fed a mixture of bone meal and cottonseed meal, 350 sheep a mixture of three parts of salt and one part bone meal, and 450 sheep on plain salt. All sheep were running in three adjoining pastures in which "Jimmies" had heretofore occurred regularly during the corresponding season of the year during which the experiment was running. Since "Jimmies" was not prevalent in the regions under investigation during the last winter, the test, of course, does not prove anything. In another test three sheep were fed grass collected during January and February from two different pastures in which "Jimmies" had occurred heretofore, but nothing similar to "Jimmies" developed in these sheep.

S. P. Mathews.

Beef Cattle Feeding Investigations

(In cooperation with Division of Range Animal Husbandry, Division of Chemistry and Bureau of Animal Husbandry, United States Department of Agriculture.)

Last year this project was carried under the heading of "Mineral Requirements of Beef Cattle in the Red Beds Regions" and had for its object determination of the amount of calcium supplement required for growing and fattening steers. Part of the steers used in this study were simultaneously utilized by the Division of Veterinary Science to make some observations on vitamin A deficiency that develop after certain modifications of the ration had been made. So important were the results of these observations that the project was revised, and the determination of the amount of carotene required for growing and fattening steers made the primary object. The basic feeding operations remained the same but this time the carotene was supplied in the form of alfalfa hay meal. The animals were first depleted on the ration until unmistakable night blindness developed, and then had definite amounts of alfalfa hay meal added to the ration in which the carotene had previously been determined. Carotene was thus fed on different levels to the different groups of steers.

The time required for depleting the steers, determined on the basis of the first appearance of night blindness, ranged from 99 days to 237 days with one exception, with the majority having developed night blindness by the end of 141 days. The exception noted did not develop night blindness during the 350 days of the experiment but showed stiffness of gait at the end of 337 days and marked swelling of the legs at the end of 345 days. Its carcass was condemned in the packing plant at slaughter 353 days after the beginning of the experiment.

Night blindness was always the first symptom to develop but soon thereafter cessation in the rate of gain or even losses in weight occurred. Sometimes swelling of the legs and keratitis would also develop. The animals in this experiment were placed on limited quantities of carotene in the form of alfalfa hay meal to forestall the development of graver symptoms. A disturbing feature was that many of the animals showed an

impairment of appetite, thus greatly reducing the amount of food taken when alfalfa hay meal that was approximately one year old was used. This condition was immediately improved when alfalfa hay meal from the new crop of alfalfa was substituted.

Steers receiving 350 micrograms or less of carotene per 100 lbs. live weight failed to show an improvement in vitamin A deficiency symptoms that had developed and showed a marked decrease in the rate of gain or even loss of weight. Steers receiving 500 micrograms of carotene per 100 lbs. body weight made as satisfactory gains as steers receiving a larger amount of carotene. However 500 micrograms of carotene was not sufficient to remedy night blindness, for this condition continued to grow worse and terminated in day blindness when permitted to progress too far before the carotene level of the ration was raised. Steers on a level of 750 micrograms of carotene per 100 lbs. body weight showed an improvement in night blindness, and complete recovery began about forty days after carotene was added to the ration provided this amount of carotene was added within one or two weeks after night blindness first developed. The time required to elapse before improvement took place depended, of course, upon the degree of night blindness that was permitted to develop before carotene was added to the ration.

Carotene storage and spectro vitamin A in the livers of the steers were higher on those animals receiving the larger amount of carotene in the ration. Thus animals receiving 500 micrograms carotene per 100 lbs. live weight showed from 0.4 to 0.6 parts per million carotene and 4.0 to 5.5 parts per million of spectro vitamin A, and those receiving 2400 micrograms of carotene per 100 lbs. live weight showed from 1.0 to 1.4 parts per million carotene and 5.6 to 7.5 parts per million of spectro vitamin A. The steer mentioned previously that had been on a depletion ration during the 350 days of the experiment, and which showed marked swelling of the legs at the time of slaughter, showed 0.5 parts per million carotene and 13.8 parts per million of spectro vitamin A in the liver. It may be noted that the carcasses from two steers that had already entered the retail meat trade were returned to the packer on account of excessive gelatinous infiltration of intermuscular tissue. The identity of these two steers could no longer be determined.

H. Schmidt.

Processing of Canned Meat

Forty cans in sizes 1 and 2, of canned meat or chicken, processed by the Division of Rural Home Research, have been examined bacteriologically both culturally and by laboratory animal inoculation for possible food poisoning organisms or bacteria contamination. These cans had been processed under 10 to 15 lb. steam pressure for a time varying from 45 to 105 minutes. Examination was made about 8 months after processing. In the interval between processing and examination the

canned meat had been stored at 110°F. for three months prior to examination. No bacteria of any kind were found in the meat.

H. Schmidt.

CHEMISTRY

Factors of Soil Fertility

Calcium carbonate, added to soils in pot experiments which had received additions of nitrogen and potash, in some soils decreased and in other soils increased the yields of corn or sorghum and the quantity of phosphoric acid taken up. Similar results were secured when nitrogen or potash were the limiting factors. Work on other factors of soil fertility is being continued, and some of this work is being prepared for publication.

G. S. Fraps.

Soils

Chemical analyses of soils of Collin, Frio, Galveston, Midland, Potter, and Van Zandt Counties and the Trans-Pecos area have been compiled. The constituents of these soils are classified in five grades, according to the quantity present, No. 1 being the highest and No. 5 the lowest grade. The grades have been designated in such a way as to carry the highest possible significance permitted by the present state of our knowledge. It is believed that this method of grading will enable the chemical properties of the soil to be more clearly brought out. This work is being published in Bulletin 533. Analyses of soils of other counties are being made and the results will be published from time to time.

The base exchange capacity has been determined in about 360 samples representing the principal types of Texas soil. The exchange capacity of heavy soils was greater than that of light soils and those from a dry section of the State had higher exchange capacity than those from less dry sections. This work has been published in Bulletin 520.

The average chemical composition of the various soil types found in Texas and also the grade assigned to the quantity of the constituents of these soils are being prepared. Maps are being drawn to show in a general way the quantities of total nitrogen, active phosphoric acid, total phosphoric acid, active potash, acid-soluble potash, total potash, acid-soluble lime, acid-soluble magnesia, basicity, and the degree of acidity represented by pH. This work will soon be ready for publication.

Mathematical equations to show the relation between the total exchange capacity and the absorption of ammonium and potassium from their sulphates have been compared with laboratory results and the best equation selected. The results have been published in Soil Science.

The phosphate-fixing power of soils has been found to be about as closely related to aluminum as to iron compounds in soils. Fixation of

phosphates from fifth-normal nitric acid is very highly correlated with iron and aluminum compounds in the soil. Only a small part of the aluminum and iron compounds is active in phosphate fixation, assuming that the normal phosphates are formed, but a large part of the fixing compounds are quite stable, requiring fairly strong, hot hydrochloric acid to dissolve them. They are not as stable, however, as the base-exchange compounds.

Increasing the acidity of soils by treating them with dilute sulphuric acid, followed by washing, did not greatly affect the phosphate-fixing power of the soils. There was some decrease in fixation to about pH 5.0, then no further decrease to about 4.5, and then a gradual decrease in fixation with further lowering of the pH.

G. S. Fraps, J. F. Fudge, and Paul Macy.

Nitrification

Practically no nitrification occurred in soils completely exposed to direct sunlight. These results confirm previous conclusions that nitrification due to sunlight is of no practical importance in soils.

Dicalcium phosphate promotes nitrification in some soils which do not respond to calcium carbonate. Different phosphates are being tested to find out which of them is most effective for nitrification on such soils. Methods for the isolation of the nitrifying bacteria and other autotrophic soil organisms are being studied. Nitrite-nitrogen is rapidly lost from acid soils as shown by German workers. Further work is being done on this phase of the subject. The estimation of the nitrifying capacity of Texas soils is being continued, and the results will be published. Some soils lose their nitrifying power after sterilization, in spite of the fact that nitrifying bacteria are added. We are endeavoring to ascertain why this occurs. The availability of nitrites to plants is lower than that of nitrates, as shown in Bulletin 515.

Nitrification is not always closely related to the number of nitrifying organisms present, so far as the number can be estimated by present methods.

Dicalcium phosphate and phosphate rock have no basic action in stimulating nitrification in soils that require additions of calcium carbonate in order to nitrify. Magnesium carbonate and dolomite are not as effective in promoting nitrification in such soils as calcium carbonate. This work is being prepared for publication.

G. S. Fraps and A. J. Sterges.

Root Rot Investigations

Soils of the Houston series, typical of the Blackland Prairies, on which root rot causes a high degree of damage, are higher in total phosphoric acid, active phosphoric acid, total nitrogen, total potash,

acid-soluble potash, active potash, lime, and magnesia, than are the fine sandy loams of the Norfolk, Kirvin, Ruston, Tabor, and Lufkin series, typical of the East Texas Timber Country, on which root rot is very limited. The Houston soils are also high in basicity and tend to be slightly alkaline in reaction (pH), while those on which root rot is of slight occurrence are of low basicity and are slightly acid. Soils of the East Texas Timber Country and the Gulf Coast Prairies, on which losses of cotton due to root rot were low, are mostly light in texture, deficient or low in phosphoric acid, nitrogen, potash, lime and magnesia, low in basicity, and slightly acid in reaction. Soils of the Blackland Prairies and Rio Grande Plains, on which losses of cotton due to root rot were high, are chiefly heavy in texture and high in fertility, as indicated by the content of phosphoric acid, nitrogen, and potash. They also have a high basicity, contain considerable limestone, and are alkaline in reaction. This work has been published in Bulletin 522.

The resistance of a Lufkin fine sandy loam to acidification by sulphur has been studied. The acidity penetrated slowly into the soil, the depth depending upon the relative quantity of the acidifying material. At the end of five years about 40 per cent of the acid had disappeared. The results are given in an article in the Journal of American Society of Agronomy.

Organic substances in the roots of certain plants inhibit the growth of the root rot fungus. This work will be prepared for publication by the Division of Plant Pathology and Physiology.

Germination of sclerotia in closed containers of known gas mixtures is somewhat variable, but preliminary results indicate that germination is better with less oxygen and more carbon dioxide than is present in normal air.

A large number of samples have been analyzed, solutions have been prepared, and other work done for the Division of Plant Pathology and Physiology. Cooperation has been given to that Division as shown in their report. Related work has been done on soils as reported elsewhere.

G. S. Fraps, J. F. Fudge, and P. F. Macy.

The Relation of Soil Composition to Plant and Animal Deficiencies

A study of the relation of soil composition to plant and animal deficiencies was started February 1, 1936. Particular attention was paid during the first year to the lime and phosphoric acid content of forage plants for range cattle, since it is known that a deficiency of these elements in the ration results in physiological disturbances in the growth and development of cattle. Over 800 samples of forage plants from 15 counties in the East Texas Timber Country and 7 counties

in the Gulf Coastal Plain were secured. Phosphoric acid, lime, and protein were determined on most of these samples; the usual feed analysis was made on several hundred samples, while potash, manganese, and copper were determined in some of them. This work is not yet completed. A large proportion of the samples contained less phosphoric acid than has been shown to be required for the proper development of cattle. This was particularly true in the case of the *Aristida* or needle grasses, which form the principal part of the forage plants covering a large part of the East Texas Timber Country. Lime was not deficient in most samples, although in many it was low. The phosphoric acid, lime, and protein content of legumes was very much higher than that in grasses grown on the same location. The work is being continued, and other areas of the state will be studied. Samples of soil from the locations from which forage samples were collected will be secured, so that the relation between the composition of the soil and the composition of the forage plants can be ascertained, if possible.

J. F. Fudge.

Commercial Fertilizers

Commercial fertilizers sold in Texas were, in general, well up to the composition guaranteed by the manufacturers, as shown by the analyses of 1034 samples published in Bulletin 529. Most of these samples were collected by the inspectors. Suggestions as to the fertilization of different crops are also given in Bulletin 529. The fertilizer manufacturers agreed upon twenty-four grades of mixed fertilizers to be sold in Texas in the season beginning September 1, 1936, and at the same meeting limited lists of grades were adopted also by Louisiana, Arkansas, Oklahoma, and Mississippi. As Referee on Fertilizers, the Chief of the Division aided in the improvement of the methods of the determining of phosphoric acid, potash, and other constituents of fertilizers and in the revision of the chapter on fertilizers in the *Methods of Analysis* of the Association of Official Agricultural Chemists. These methods are required by law to be used in Texas and other states. Assistance was also given in the formulating of definitions of fertilizers by the A. O. A. C., and informal cooperation was given in other ways to officials in other states.

G. S. Fraps, S. E. Asbury, and T. L. Ogier.

Loco Poison

The toxic principle of the loco weed, *Astragalus earlei*, has been isolated in comparatively pure form and has been named locoine. It is a hygroscopic organic base, forms salts with acids, and is difficult to isolate and to purify. It does not contain selenium. Small quantities fed daily will loco cats in the usual time of about two months. It is precipitated by phosphotungstic acid and can be recovered from the

precipitate by treatment with barium hydroxide. The base can be acetylated by acetic anhydride and the toxic principle recovered by extracting the water-soluble material with chloroform, evaporating off the chloroform and saponifying with sodium hydroxide. The tartrate, citrate, chloride, and oxalate salts have been prepared. This work is being published in Bulletin 537.

The method for the isolation of locoine has been improved. A number of locoine salts have been prepared, of which the phosphotungstate has been isolated in crystalline form. An ash-free locoine has been prepared and its phosphotungstate crystallized. Two more species of loco weed, *Oxytropis saximontana* and *Astragalus mollissimus*, are being investigated for poisonous alkaloids. The properties of locoine and its salts are being studied.

G. S. Fraps, E. C. Carlyle, and A. W. Walde.

Productive Values of Animal Feeds

An extensive series of slaughter experiments with chickens shows that the productive energy of the mixture used is very nearly the same as its productive energy calculated from its composition and factors given in Bulletin 372. These experiments will serve as a basis for estimating the productive energy of other feeds by the same method of experiment. It is hoped by this work to increase the accuracy of the factors used for calculating the productive energy of feeds. The work is being prepared for publication.

G. S. Fraps.

Productive Values of Human Foods

More than 1250 human digestion experiments have been tabulated, and the compilation will be made as nearly complete as possible. Data thus obtained are being classified and studied. The results will be used in the calculation of productive values. Digestion experiments with a number of human foods have been carried out, using rats as experimental animals. It is planned to investigate the digestibility of human foods by rats when incorporated as part of a balanced ration. Digestion experiments with oatmeal by two men were made. The digestibility of other foods by men will be determined. The productive values of some human foods are being determined by means of rats, fed according to the paired-feeding technique. At the end of the experiment the rats were killed and analyzed, and the productive values will be calculated from the gain of protein and fat. Chicks will be used in similar experiments. One experiment has been run to determine the biological values of the protein of corn meal, oatmeal, raw navy beans, and cooked navy beans. The protein of the beans was decidedly lower in biological value than that of either corn meal or oatmeal. Mixtures containing the raw beans were eaten sparingly.

Samples of human foods that are being collected for this work are being analyzed for carbohydrates, proteins, and fats and also for minerals including copper and manganese. E. C. Carlyle.

Variations in the Vitamin Content of Foods and Feeds

The vitamin A content of butter may vary from 4 to 100 International units per gram, according to the feed of the cow, and upon the period of lactation. If the cow is being furnished carotene in liberal quantities of about one million micrograms of carotene a day, the butter produced may contain about 100 International units of vitamin A potency to the gram. If the cow received liberal quantities of vitamin A before the lactation period and is then fed smaller amounts, the vitamin A potency of the butter will decrease during the period of milking. If the cow does not receive liberal quantities of carotene before the period of lactation and is then fed food low in carotene, the butter fat may eventually contain as little as 5 International units to the gram. The potency of egg yolk is likewise dependent upon the feed of the hen and may be as high as 50 units to the gram if feed rich in carotene is fed or as low as 4 units to the gram if the feed is poor in carotene.

The amount of spectro-vitamin A and carotene in 32 samples of butter was estimated in parts per million by spectrographic methods and in Sherman Munsell units by rats. With the data obtained, a method was formulated for calculating the Sherman Munsell units or International units from the parts per million of spectro vitamin A and carotene. This work is being prepared for publication.

The vitamin A potency of one microgram of carotene in alfalfa, carotene dissolved in oil, and carotene in the International standard for vitamin A was found to be equal to 1.4 Sherman Munsell units (1.7 International units). One microgram of carotene in yellow corn was found to equal 1.2 Sherman Munsell units (1.4 International units). This work has been published in the Journal of Agricultural Research.

Investigations on the relation of carotene in foods and feeds to their vitamin A potency are being carried on. Information on the relation in certain foods and feeds is being published.

Studies on the vitamin A potency of grasses and browse used by range cattle for food is under way with special reference to the grasses and browse found in those sections subject to long periods of drought.

Preliminary studies on the effect of different planes of carotene intake as the sole source of vitamin A potency, on the health and longevity of albino rats, have been started. When conditions warrant, results will be published.

G. S. Fraps, Ray Treichler, and A. R. Kemmerer.

The Quantitative Occurrence of Vitamin A in Animal Feeds

This work is closely related to cooperative work on the quantitative requirements of chickens, dairy cattle, beef cattle, pigs, and sheep for vitamin A and of vitamin D for chickens, which has been undertaken in 6 projects in cooperation with the Division of Poultry Husbandry, Dairy Husbandry, Swine Husbandry, Range Animal Husbandry, and Veterinary Science. The work with beef cattle and sheep is also in cooperation with the Animal Husbandry Division of the Bureau of Animal Industry, United States Department of Agriculture. Carotene has been determined at regular intervals in the alfalfa fed the animals in these experiments, and spectro-vitamin A and carotene have been determined in a number of samples of liver from chickens, beef cattle, pigs, and goats in various stages of depletion. Considerable quantities of carotene have been found in the excrement from dairy cows and chickens receiving liberal amounts of carotene from green pastures. The relation between the composition of the feed and the vitamin A potency as measured by biological methods is being determined.

It appears that 125 Sherman-Munsell units of vitamin A potency, or 114 micrograms of cryptoxanthin and carotene from yellow corn per 100 grams of feed, may be sufficient for growing chickens under some conditions. Under less favorable conditions, 150 Sherman-Munsell units of vitamin A potency, or 136 micrograms of carotene equivalent from yellow corn per 100 grams of feed, may be necessary. Chicks hatched from eggs laid by hens on low vitamin A rations may require as much as 300 units of vitamin A potency, or 270 micrograms of carotene from yellow corn per 100 grams of feed. This work, in cooperation with the Division of Poultry Husbandry, is published in Bulletin 528.

For the first 12 weeks of life, growing chickens fed a ration containing 1.48 per cent calcium and 0.65 per cent phosphorus required 12.3 International units of vitamin D from cod liver oil per 100 grams of feed for maximum growth and best utilization of the feed. Chickens fed a ration containing 0.96 per cent calcium and 0.66 per cent phosphorus required up to 12 weeks 50.2 International units of vitamin D from cod liver oil per 100 grams of feed for maximum growth, best utilization of the feed, and calcification of the bones, and 12.3 International units of vitamin D from cod liver oil per 100 grams of feed for the prevention of rickets and crooked breast bones. This work, done in cooperation with the Division of Poultry Husbandry, is published in Bulletin 521.

Dairy cows are not as efficient as laying hens in utilizing vitamin A, since they utilized only about 2.5 per cent of the vitamin A potency fed to them while the chickens utilized 25 per cent. If correction was not made for the vitamin A stored in the cow, the apparent recovery

varied from 213 to 2.4 per cent. Vitamin A potency of the butter increased from 12 units per gram to 50 units per gram in 3 days after the cows were placed on good pasture. This work, done in cooperation with the Division of Dairy Husbandry, is published in Bulletin 536.

G. S. Fraps, A. R. Kemmerer, and Ray Treichler.

Vitamins in Commercial Feeds

The vitamins important in commercial feeds seem to be vitamin A, vitamin G, and vitamin D. Vitamin C does not seem to be required by domestic animals. Vitamin B and vitamin E are extensively distributed in ordinary feeding stuffs. Cottonseed oil and cottonseed meal are very rich in vitamin E. Vitamin A occurs in commercial feeds chiefly as carotene in alfalfa meal and carotene or cryptoxanthin in yellow corn. Peanut hay also contains carotene, and fresh green grasses are very high in it. Ordinary alfalfa meal may contain as little as 6 parts carotene per million, while carefully selected alfalfa leaf meal may contain as much as 200 parts per million of carotene. Vitamin A appears to be most important in feed for chickens that do not have access to green feed. Vitamin D is needed only by such animals, chiefly chickens, as are not exposed to direct sunlight, while vitamin G also is needed mostly by chickens. Vitamins are generally furnished in sufficient quantities by the usual feeding stuffs, when they are properly mixed. Exaggerated statements are sometimes made regarding vitamins in feeds, especially in efforts to sell expensive complicated mixtures. This work was conducted with funds from the Division of the Feed Control Service to September 1, 1936 and will be continued as facilities permit until it has been published.

Feeds enriched with vitamin A by the incorporation of cod liver oil lost all of the vitamin added in less than four weeks of storage. The rate of loss was practically the same at either room or refrigerator temperatures. Carotene in alfalfa, or in feeds to which carotene in oil had been added, was destroyed to some extent during storage but not nearly as rapidly as the vitamin A added to feeds in the form of cod liver oil. The rate of the destruction of carotene was less rapid when the feeds were stored at refrigerator temperatures than it was when the feeds were stored at room temperatures.

The estimation of the vitamin D content of mixed feeds was attempted by means of the line test with rats. The calcium and phosphorus in the feeds interfered with the test to a considerable extent. Therefore attempts were made to extract the vitamin D from feeds with several different solvents. The solvent which gave the best results was hot 95 per cent alcohol.

The vitamin D content of some commercial cod liver oils was tested by means of chickens. A few of the samples were found to be not as potent as they were claimed.

G. S. Fraps, A. R. Kemmerer, and F. D. Fuller.

Analyses of Commercial Feeds

Estimation of protein, fat, crude fiber, water, ash, and the microscopic examination were made on about 3471 feeds for the Division of Feed Control Service in the year ending August 31, 1936. Salt and carbonate of lime were also estimated in a large number of samples, and in many cases the percentages were found to be considerably higher or lower than was claimed by the manufacturer. Some samples of molasses were analyzed for salt and for sugar. A number of legal analyses were made. Hardness of cottonseed cake was also tested in about 10 samples. Lime and phosphoric acids were determined in some feeds in which these were guaranteed to be present. Assistance was given in the formulation of definitions and rulings and in other respects. This work is being published in bulletin 532 by the Division of Feed Control Service.

Cooperation was given the officials of other states on formulating new definitions of feeds and improving old ones, and in securing a greater degree of uniformity in regulations and rulings, individually and through the Association of American Feed Control Officials.

G. S. Fraps and T. L. Ogier.

Chemical Analyses and Investigations of Feeds

A number of forage plants have been analyzed for minerals and for proteins, fats, etc. for the Divisions of Range Animal Husbandry and of Dairy Husbandry under this project. This project was supported by funds from the Division of Feed Control Service until about May 1, 1936. Some of this work will be continued.

G. S. Fraps and F. D. Fuller.

Low-Grade Feeds

Low-grade feeding stuffs, consisting of materials low in feeding value compared with ordinary commercial feeds, are present in some commercial mixed feeds. The number of such feeds and the quantity of low-grade feeds present are greater during periods of high prices of feeds than during periods of low prices. Some of these feeds have little or no feeding value but the feed law permits them to be sold in mixed feeds when the percentages of all the ingredients are shown on the tag so that the purchaser can know what he is buying. During some periods, these mixed feeds sell at prices which are not unreasonable compared with their feeding value and the price of concentrated commercial feeds. During other periods, the price of feeds containing low-grade ingredients is high compared with their feeding value, so that these feeds do not furnish feeding value in proportion to the price paid. This work was supported with funds from the Division of Feed

Control Service until May 1, 1936. It will be continued and the results published as facilities permit.

G. S. Fraps and F. D. Fuller.

Minerals in Commercial Feeds

Lime, phosphoric acid, and other minerals are being estimated in some commercial feeds for the purpose of preparing tables that will enable the mineral content of feed mixtures to be approximately calculated. A comparison of the calculated mineral composition of mixed feeds with the recommendations by authorities on the subject, it is hoped, will enable recommendations to be made for additions of minerals necessary to improve mixed feeds. A large number of samples were examined for carbonate of lime and salt. In some cases excessive amounts were present, while in other cases none was found in spite of claims that they were present. An improved method for estimating salt was devised. This work was supported by funds from the Division of Feed Control Service to February 1, 1936 and it is intended to complete the work which has been done and prepare it for publication.

G. S. Fraps and F. D. Fuller.

Hardness of Cottonseed Cake

Soaking specimens of cottonseed cake in water materially decreased their crushing strength. The decrease was about one-third for the first 5 minutes of soaking and about one-half for 20 minutes of soaking. Moistening with saliva therefore decreases the force required to crush the cake in the mouth of the animal. Feeding tests with cows and sheep showed that while the size, shape, and hardness of the cottonseed cake seemed to have some effect, the idiosyncrasies of the animals themselves seem to be the controlling factor in the consumption of cottonseed cake by the animals. Some cows would eat hard cake readily, while other cows could hardly be induced to eat soft cake. Cake with a crushing strength of less than 400 pounds is tentatively classed as soft for cows; cake with a crushing strength of from 400 to 1500 pounds is tentatively classed as medium hard for cows; cake with a crushing strength of 1501 to 2500 pounds is classed as hard; and that with a crushing strength of over 2500 pounds is classed as very hard. Details have been published in Bulletin 523.

Crushing strength of different parts of the slab of cottonseed cake varied from 2600 to 3500 pounds. No constant regions of hardness or softness were found. No definite relations were found between the chemical composition and the hardness of the cake. A rapid change in moisture content of the cake resulting in a lowering of the crushing strength, contrary to expectations. Meats with high moisture content produced a soft cake. Storage for approximately two years had no appre-

ciable effect upon the hardness of the cake. This work is being published in Bulletin 534. Intensive work on this project has been discontinued, but a limited number of samples of cottonseed cake is being collected by the Feed Control Service and tested for hardness.

G. S. Fraps and C. D. Marrs.

Iodine

Texas feeds and drinking waters seem to contain sufficient quantities of iodine for various animals so that there is no necessity for the addition of iodine to commercial feeds or to salt for animals. The iodine content of some of the samples of foods and feeds was quite high. In none of the samples was it low enough to indicate the need of iodine. This work is being continued, with special attention to iodine in cottonseed meal and water supplies.

G. S. Fraps and J. F. Fudge.

Sugar Beets

A number of samples of sugar beets grown in different parts of the State have been tested in past years for sugar and purity. The sugar beet is grown during the spring and summer in cool climates, but in Texas it was planted in the early fall and harvested in June. Some of the samples of beets contained enough sugar and a sufficient degree of purity for manufacturing purposes, while others were not satisfactory. The sugar in sugar beets usually decreases as warm weather comes on. For this reason, it is not possible to store the beets without so much loss of sugar as to render them unsuitable for manufacturing. This evidence indicates that sugar beets grown in the winter and spring cannot practically be manufactured into sugar during the summer. There is little prospect of the production of sugar from sugar beets in most of the State of Texas.

G. S. Fraps.

Miscellaneous

Samples of various feeds, limestone, oyster shell, irrigation water, and other materials have been analyzed for other divisions or in connection with other work.

G. S. Fraps.

HORTICULTURE

Adaptability Investigations with Fruit Crops

(In cooperation with the Texas Extension Service)

In order to determine the proportion of winters with sufficient cold weather for commercial peach production in different parts of the State,

the temperature records of 100 stations, covering periods of from 10 to 40 years, were examined. The number of winters having at least 800 hours below 45°F. was calculated, since approximately this amount of cold is considered necessary for normal production of most commercial varieties of peaches. The resulting map shows that latitude, elevation, and the Gulf are important factors in determining the duration of cold. That portion of the state north of the thirty-second parallel and west of a line from Eastland to Denison always has a sufficient number of hours below 45°. South of this line to the northern edge of San Saba, Henderson, and Rusk counties, 1 year out of 10 on the average will be too mild. The remainder of the Edwards Plateau and a strip east including Coryell, Freestone, and Panola counties may expect to lose one crop in five because of insufficient cold weather. Below the Edwards Plateau and including the entire Gulf Coastal plain from 7 to 9 winters out of 10 are too mild for any but the Honey varieties of peaches. There is never enough cold weather south of Webb and Nueces counties for the commercial varieties. Breeding new varieties of peaches for areas having a large proportion of mild winters is discussed in another section.

Budwood of additional promising chance seedlings of peaches and plums have been received and propagated for testing during the year. Material already propagated has been sent to substations in regions where it is expected to do well. Information in regard to other seedlings that have shown up well is requested.

A report on the behavior of fruit varieties at the Wichita Valley station is being published as a station bulletin. Time of bloom, length of blooming period, and hardiness were all found to be of importance in determining the production of the different varieties of peaches. Results with the European (*vinifera*) grape varieties at the Winter Garden Station are very encouraging for the commercial production of early grapes in the southern part of the State. This region can probably compete successfully with other early grape areas, and suitable soils and irrigation water are available. More information on this project is given in the reports of Substations No. 11, No. 16, and No. 19.

S. H. Yarnell, J. F. Rosborough, and substation superintendents.

Berry Breeding

The Young dewberry and the Crandall's Early and Hall's Lawton blackberry varieties have been used extensively as pollen parents in inter-varietal berry crosses at Substation No. 11, Nacogdoches. A large population of seedlings resulting from open pollination of the self-sterile McDonald blackberry are very similar to the seed parent. Slight differences among the seedlings indicate that they are true hybrids and that characters of the McDonald parent are dominant.

At College Station two selections of the Nessberry crosses have considerable promise. One is a very early, large dewberry of high quality.

The second is upright in habit of growth. It is unusually late and has more of a raspberry flavor than the Ness parent. Both selections are vigorous and drought resistant. They are being propagated by means of stem cuttings treated with indolyl acid and grown with bottom heat.

H. F. Morris, S. H. Yarnell.

Cultural Studies with the Blackberry

At Substation No. 11, Nacogdoches, the proportion of sterile plants has increased to the point where differential cultural treatments have had to be abandoned, and a study of this defect undertaken. Affected plants have nearly twice as many canes as the normal, but they are thinner and have fewer laterals. The number of achenes per fruit is reduced from around 75 to only 6, which makes the fruit worthless. The number of fruits per cane is reduced by about 15 per cent. The seeds from the sterile plants are slightly larger than normal. The effect of pollination and various environmental factors, and development of the fruit are being studied. While some sterility has been observed in the plats at Substation No. 2, it has not yet seriously interfered with the cultural work at that point.

H. F. Morris, J. C. Ratsek, S. H. Yarnell.

Citrus Investigations

Adaptability and Breeding: The new Texas Navel orange averages 48 per cent juice, which compares favorably with the 43 per cent juice of the Washington Navel. It has 4 seeds per fruit, slightly more than the latter, which averages 3.43 seeds per fruit. On the whole the Texas Navel is slightly more tart than the Washington Navel, which gives it a more pleasing flavor. Seedlings have been obtained at the Lower Rio Grande Valley station from crosses between Ruby orange and Meyer lemon, Pineapple orange and Pink Marsh grapefruit, and also Thornton tangelo using Clementine orange and Pink Marsh grapefruit as pollen parents. All of the citrange seedlings survived a temperature of 16°F. at College Station without injury during the winter of 1935-1936.

W. H. Friend, E. Mortensen, J. F. Wood, S. H. Yarnell.

Rootstocks: For an account of this work turn to the reports of Substation No. 15, Weslaco, and Substation No. 19, Winter Haven.

W. H. Friend, E. Mortensen.

Cultural Studies with Grapefruit: Good results have been secured by the use of bonemeal in the old grove at the Lower Rio Grande Valley station.

W. H. Friend.

Deterioration of Bearing Orchards: Soil type has been more important in influencing yield and condition of grapefruit trees than any soil treat-

ment made. Beneficial effects have been secured with applications of organic matter, and of 10 pounds per tree of 10-30-10.

W. H. Friend, J. F. Wood.

Orchard Heating: The work was extended to include oranges and lemons this season. Adequate protection was obtained with two types of oil heaters.

J. F. Wood.

Citrus Storage: Grapefruit and oranges kept well for 10 weeks at room temperature in aluminum foil wraps. Fruit so wrapped and previously stored at 45°F. kept several weeks after removal. Moisture-proof cellophane was also found to be effective. Meyer lemons when wrapped colored well without any coloring treatment.

W. H. Friend, J. F. Wood.

Grapefruit Maturity: This work in cooperation with the U. S. Department of Agriculture, Bureau of Chemistry and Soils and the State Department of Agriculture concluded a cooperative project during the past year. The study includes a series of physical and chemical measurements of grapefruit developing under different conditions. Results are presented in the report of Substation No. 15.

J. F. Wood, H. M. Reed.

Adaptability of Date Varieties

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

There was very little fruiting this year at either substation (No. 15 and No. 19). This was possibly due to cool weather during the spring.

J. F. Wood, E. Mortensen.

Fig Investigations

Adaptability and Breeding: The use of a hypodermic needle just large enough to fill the eye of the young fig and having a bulb attached was found to be very successful in making the crosses. A small hole was made in the upper part of the flower to allow air to escape. This provided excellent pollination judging from the number of seed obtained. Crosses were made with pollen from a *Hamma capri* using *Magnolia*, *Allison*, *Celestial*, and *Green Ischia* as seed parents.

R. H. Stansel, S. H. Yarnell.

Processing Experiments: These include the development of a sub-standard pack, spiced figs, conserves, crushed, and ground figs. Work was also done on a fig beverage, dried figs, and fig sirup, and on prolonging the keeping time of fresh figs. The work is presented in detail in the report of Substation No. 3.

H. M. Reed.

Grape Investigations

In continued tests of rootstocks at Substation No. 19, Dog Ridge, Champanel, and La Pryor have given very good results when grafted to vinifera varieties. Additional wild vines were included this year. Mustang seedlings gave a high per cent of successful grafts.

E. Mortensen.

Peach Breeding

The peach breeding work has two objectives: (1) to secure desirable varieties that will develop normally after a mild winter and (2) to develop an early yellow freestone of commercial quality. The lack of ability of most varieties not belonging to the Honey type to fruit after a mild winter is discussed under fruit adaptability. To meet this difficulty the following crosses have been made reciprocally: Pallas x Hiley, Pallas x Indian Cling, Smith x Indian Free, Smith x Slaphey, Florida Gem x Anna, Luttichau x Salwey, Luttichau x Dr. Burton, and Triana x Elberta. In each case one of the parents is of the Honey type, requiring very little cold weather. All of the other parents except Dr. Burton and Elberta require less cold for normal development than most of the commercial varieties.

Crosses to develop an early yellow commercial variety are being made at Substation No. 16 in the Wichita Valley. Early Wheeler, a late-blooming, early-fruited variety is being crossed with J. H. Hale, a large yellow freestone. Mayflower, which also blooms late and fruits early is being crossed with Salwey, likewise a large, yellow freestone. Other crosses are Carman x J. H. Hale, Dr. Burton x Triumph, and Slaphey x J. H. Hale. All crosses were killed by a late freeze last spring when about the size of a pea.

S. H. Yarnell, L. E. Brooks.

Plum Breeding

The object of this work is the production of late blooming and early fruited varieties of improved quality. While most northern plums are considered to be intercompatible, at least partial incompatibility was observed between certain hybrid varieties representing several species. The species of *Prunus* involved in the southwestern cultivated plums include *munsoniana*, *triflora*, *angustifolia*, *besseyi*, *hortulana*, (also *hortulana mineri*), *cerasifera*, *americana*, *simonii*, and *domestica*. Several of the best varieties are compound hybrids having been derived from 3 or 4 species. A study of the relationships among a number of these forms is being made in connection with the breeding work.

W. S. Flory.

Comparison of Pecan Seedling Rootstocks

Additional data show that the more vigorous seedlings give the greatest cion growth. The selection of seed for rootstock purposes should be

based on performance. Native trees may or may not produce the best seedlings. Combinations of Hollis, Success, and Oliver may be expected to give satisfactory seedling rootstock material. Source of pollen is as important as the seed parent.

S. H. Yarnell.

Strawberry Adaptability and Breeding

The following four selections of crosses made at Substation No. 19 were found both to be earlier and to have larger fruits than Missionary: Excelsior x Aroma, and Missionary pollinated with Aroma, with Banner, and with Redheart. The last cross has the best quality. Thirty-four selections either equalled or excelled Missionary in total yield. Sixteen selections were found worthy of more extensive trial.

E. Mortensen, S. H. Yarnell.

Cytological Studies on Species Hybrids in Citrus, Fragaria, and Rubus.

A report on chromosome behavior in Rubus appeared in the Journal of Agricultural Research. In a study of the somatic chromosomes of citrus, at least one pair has been found to have a satellite. Both root tips and pollen mother cells are being examined. The material includes both commercial and related wild species.

S. H. Yarnell.

Investigations of the Adaptability with Truck Crops.

Work on vegetable varieties is being continued at Substations No. 15, 16, and 19. The production of English peas and the canning of vegetables are assuming increased importance in the Lower Rio Grande Valley. In the Winter Garden region, less emphasis is being placed on spinach and onions. Information in the newer varieties is included in the reports of the substations mentioned.

L. R. Hawthorn, W. H. Friend, L. E. Brooks, J. F. Wood.

Asparagus Fertilizers

The results of this project will be found in the report of Substation No. 16, Iowa Park.

L. E. Brooks.

Breeding Cabbage and Related Plants

Cabbage: Selections of desirable plants have been made from commercial fields of the varieties best adapted, i.e., (1) globular type: Copenhagen Market, Marion Market, Glory of Enkhuizen; (2) flat type: All Head Early, All Seasons; (3) long or pointed type: Early Jersey Wakefield. Also selections of Charleston Wakefield, Savoy, Volga, and the red cabbages have been made for cold resistance. Selected plants are

stored for 60 days at 40°F. to break their dormancy, after which they are placed in the field in the spring, or potted in the greenhouse in the winter. When these plants flower, the best representatives of each head type will be crossed reciprocally with one or more of the cold-resistant varieties. Both back-crossed and second generation populations will be grown, with selections for early, hardy strains of the three shapes of head.

Other Crucifers: Representatives of all the botanical varieties of *Brassica oleracea*, and in addition several varieties of the Chinese cabbage *B. pekinensis*, are being grown for breeding purposes. These are either being selfed to produce more homozygous lines, or are being crossed with each other in attempts to produce new or improved horticultural forms combining the best characters of each parent. All attempts to date to cross *B. oleracea* with *B. pekinensis* have failed, but new methods of procedure are being tried.

Selected plants of Georgia collards, of Green Sprouting broccoli, and of Pe Tsai Chinese cabbage have been selfed. Plants resulting from these selfings are being grown. Two vigorous F_1 plants have been obtained from the cross Georgia Collards x Green Sprouting broccoli.

W. S. Flory, S. H. Yarnell.

Factors Affecting the Storage of Cucumbers

For information concerning this project turn to the reports of the Division of Rural Home Research and of Substation No. 19.

L. R. Hawthorn, Jesse Whitacre, S. H. Yarnell.

Factors Influencing Quality and Yield of Onions

This work is being done at Substation No. 19. A report has been published as Bulletin No. 524.

L. R. Hawthorn.

Factors Influencing Quality and Yield of Spinach

Because of the severe infestation in the Winter Garden area of the virus causing curly top of sugar beets, attention has been devoted to finding if possible a variety or strain of spinach resistant to this disease. Seed from foreign sources are being grown. This was received through the Division of Foreign Plant Introduction, U. S. Department of Agriculture.

L. R. Hawthorn.

Tomato Investigations

Adaptability and Breeding: Selections have been made from second generation intervarietal crosses at the Lower Valley Station. At the

Winter Garden Station further selection of the Cherry-Bonny Best cross has given a very satisfactory set of fruit during the mid-summer season, which is unfavorable for fruit setting of the commercial varieties. Similar results have been secured with crosses between large and small fruited sorts at the Main Station. Additional breeding work will be discussed under puffing.

J. F. Wood, L. R. Hawthorn, S. H. Yarnell

Cultural Experiments: These involve work with fertilizers and irrigation at Substation No. 15, and work with spacing and fertilizers at Substation No. 19.

W. H. Friend, L. R. Hawthorn.

Studies on Puffing: Varieties with oblate fruits and many locules, as the Bonny Best Type, have less puff both at Substation No. 15 and at the Main Station than varieties with globular fruit and relatively few locules. Results with fertilizers and irrigation at the former point have not been very consistent. Additional data secured at the Main Station support the belief that environmental factors affect puffing chiefly at a very early stage of fruit development. Selected strains of Bonny Best, Earliana, Kanora, Marketeer, Stone, and Success have been found to give a relatively low proportion of puffed fruits. Twelve first generation families of a "double cross," involving four varieties, had a smaller proportion of puffed fruit during the second harvest period than any large fruited variety in the test this season. All but two families of this type of cross had below 10 per cent puff during the first harvest period which compares favorably with the best commercial strains, and all but three had under 30 per cent puffed fruit during the second period in spite of heavy rains. Commercial varieties had the following percentages of puff during the second period: Break O'Day 57, Glovel 48, Marglobe 52 to 58, and Pritchard 46 to 49. Third generation selections of crosses with small fruited types have even less puff than the double cross. Fruit size for these is still under normal. Back crosses to large fruited sorts have given larger fruits, but also more puff, with one exception about the same as the double crosses. The exception had about the same amount of puff as the F_3 selections.

S. H. Yarnell, W. H. Friend, J. F. Wood.

Description of Vegetable Varieties

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

Work with turnips and rutabagas is being continued at Substations No. 16 and No. 19 this year.

L. R. Hawthorn, L. E. Brooks.

Investigations with Ornamentals

Adaptability: Increasing attention is being paid to native shrubs and trees for ornamental purposes. During the fall, seeds were collected from a number of natives in the western part of the State, including

the Chisos mountain area of the "Big Bend" country. Additional native material is being grown at a number of the substations, particularly No. 2, No. 8, No. 9, No. 11, No. 16, and No. 19.

S. H. Yarnell, L. E. Brooks, J. C. Ratsek,
substation superintendents.

Breeding: Among the oleander plants at the Winter Garden station it was noted, following the prolonged cold of the winter of 1935-36, that while plants of most of the color forms had been decidedly "burned" by the low temperatures the yellow double-flowered form remained apparently unaffected. To take advantage of this factor for cold resistance, crosses were made between the yellow-flowered forms and those bearing flowers of other colors. Crosses were also attempted between the other white, pink, red, and "peach" forms on the chance that genic recombinations might result in new forms that would be horticulturally desirable. In addition to the color and cold resistance characters each of these types exhibit some distinct genetic differences the analysis of which promise to be interesting if F_1 and F_2 generations can be secured. The crosses attempted were yellow x white, yellow x red, pink x yellow, white x yellow, red x yellow, red x pink, red x white, red x "peach," pink x red, and white x red. From 171 flowers pollinated, about 1700 seeds resulted from the following combinations: yellow x red, 560 seeds; yellow x white, 47; red x yellow, 300; red x peach, 800. A high percentage germination is being secured from these.

W. S. Flory.

Propagation: Several procedures are being followed in attempting to propagate desirable F_1 and F_2 hybrid trees of the cross made by the late H. Ness between the live oak (*Quercus virginiana*) and the overcup oak (*Q. lyrata*). To date, these procedures have dealt only with stem cuttings. Cuttings from a vigorous *Vitex* plant and from three lots of selected hybrid berry plants were also subjected to the same treatments. The cuttings are being tried in 4 different rooting media: (1) one-half river sand to one-half peat moss, (2) pure river sand, (3) one-half sharp building sand to one-half peat moss, and (4) pure sharp building sand. Most of the cuttings are placed in a propagating bench which is supplied with bottom heat (to about 70°F.) by electric cables; control lots are run in a bench with no bottom heat. Prior to placement in the propagating bench the bases of the cuttings are soaked in solutions of the growth hormone indolyl acetic acid. Four concentrations of the acid are being tried: (1) 5 mgs. per 100 c.c. water for 52 hours; (2) 10 mgs. per 100 c.c. water for 40 hours; (3) 20 mgs. per 100 c.c. water for 24 hours; and (4) 40 mgs. per 100 c.c. water for 6 hours. Control lots are placed in distilled water for equivalent periods. Early indications are that cuttings given bottom heat in one-half building sand to one-half peat moss are more likely to callus than those not given bottom heat or those placed in other media. In addition to attempting propagation of the hybrid oaks by stem cuttings, budding and grafting on the parent

species and on other oaks is contemplated. With this in mind about 2000 acorns have been gathered and stratified to facilitate germination and seedling production.

W. S. Flory, S. H. Yarnell.

Roses: Three projects to study the effect of various horticultural practices on dieback of roses were initiated this year. The work includes investigations on rootstocks, fertilizers, spacing, pruning, and handling after the plants are ready for harvest. The work is being done at Substation No. 2.

J. C. Ratsek.

RANGE ANIMAL HUSBANDRY

A Study of the Inheritance of Skin Folds on Rambouillet Sheep

(In Cooperation with Bureau of Animal Industry, U. S. Department of Agriculture)

Records taken in the Station flock show that the wrinkly types of Rambouillets produce heavier unscoured fleeces than produced by smooth animals. However most of the advantage is lost when the fleeces are compared on a clean basis. The smooth type produced a longer stapled fleece than the wrinkly type. There was no difference in average fineness of fiber between the types, but the smooth type was more uniform in fineness.

Seven F_1 progeny from a B type Rambouillet ram X Corriedale ewes (free from wrinkles) have been raised and examined after the first fleeces were removed. In every case the number and size of the skin folds were small. Compared with their sire as 100, they ranged from 4 to 27. This points to the probability that there is some dominance of the genes for freedom from skin folds.

J. M. Jones, B. L. Warwick, W. H. Dameron,
S. P. Davis, H. C. McPhee, D. A. Spencer.

Inheritance of Type in Angora Goats

Additional data are being analyzed by use of the conversion tables, but no new conclusions have been reached.

J. M. Jones, B. L. Warwick, W. H. Dameron, S. P. Davis.

Inheritance of the Ridgling Characteristic in Goats

Additional data confirm the conclusion that this defect is due to recessive genes. The two pairs of recessives are probably duplicate.

Sire testing has been continued in the hope of identifying males free from the genes for the ridgling defect. One normal buck was bred to does in a flock in which 12 per cent of the male kids have been ridglings during the last three seasons. Forty-three normal buck kids and no ridglings were sired by this buck during the last two years. Another

normal buck used in the same flock sired 9 ridglings among 20 male progeny. It is tentatively concluded that the first buck mentioned is homozygous for the genes for normal, but is being tested further.

B. L. Warwick.

Inheritance of Polled Character in Fine Wool Sheep

Further data confirm the conclusions that polled (hornlessness) in Rambouillet sheep is dominant. Moreover cryptorchidism or the ridgling character as found in this stock is recessive to normal. The tentative conclusion that the genes for horned (Rambouillet or Merino), horned (Dorset) and polled constitute an allelomorphic series has been confirmed by critical test matings. Sires are being tested to find more rams which are homozygous for polled and to find polled rams free from the recessive gene for cryptorchidism.

B. L. Warwick, J. M. Jones, W. H. Dameron, P. B. Dunkle.

Cytological and Hybridization Studies with Sheep and Goats

(In cooperation with Department of Biology, School of Arts & Sciences,
and Department of Genetics, School of Agriculture, A. and M.
College of Texas)

Further study of cytological preparations from the amnion of sheep and goats confirms the previous tentative conclusion that these species differ in the number and the shape of their chromosomes.

Additional matings of male sheep to Angora goats resulted in about half the females becoming fertilized, but the embryos all perished before the end of the gestation period. Matings of female sheep to a male goat were made. Many of the services were checked microscopically and abundant sperm demonstrated. None of these sheep became pregnant from breeding to the goat. In some cases the ewes were killed two days after breeding to the goat and the oviducts removed and taken to the laboratory. The eggs were washed out of these oviducts by means of saline solution and examined under the microscope. In no case was there evidence of fertilization.

Study of the hybrid embryos by sectioning showed that most of the differences consisted of retardation of development, especially of the brain and spinal cord. The 62-day hybrid embryo had the infra-orbital glands, which are present in sheep and absent from goats.

Further study was made of the oestrogenic hormone in the urine and blood serum of sheep and goats, looking to its possible use in diagnosing pregnancy in these species. The level was found to be too low to be utilized.

B. L. Warwick, R. O. Berry, W. R. Horlacher.

Disease Resistance in Animals

(In cooperation with Division of Veterinary Science)

This project was initiated during the year. The studies are concerned, for the present, with resistance of mice to the nematode parasite *Nippostrongylus muris* and to the toxin of loin disease. Preliminary work has been done with each.

B. L. Warwick, H. Schmidt, R. D. Turk.

Mineral Requirements of Cattle in the East Texas Region

Substation No. 2, Tyler, Texas

The forty 600 pound yearling Hereford steers placed at this Station September 6, 1933 were marketed as 1227 pound fat steers December 17, 1935.

Two pounds of cottonseed cake were fed per head daily from November 20 to April 1 for each of two wintering periods in addition to grazing and a small amount of hay which was produced at the Station. The steers were fed 5 pounds of cottonseed cake per head daily from August 1 to October 17, 1935, after which they were fed a fattening ration for 56 days in dry-lot and then marketed.

Of the four groups into which the steers were divided, one group received salt only as a lick; one group was fed .12 pound pulverized oyster shell per head daily during the wintering periods with salt as a lick; one lot received salt lick consisting of two parts bone meal and one part salt; and the remaining lot, a salt lick consisting of two parts salt, two parts pulverized oyster shell, one part cottonseed meal, and one part bone meal. The average salt consumption (salt licks free choice) for all steers was .93 ounce per head daily from April 11, 1934 to April 10, 1935. The group supplied bone meal and salt consumed 1.75 ounces of bone meal daily during the same year, while the group supplied the varied mixture of salt, pulverized oyster shell, bone meal, and cottonseed meal consumed slightly more salt than any other group, 1.16 ounces per head daily. The group receiving salt only made the highest gain.

The productive season for pasturage extended from April to November.

The net gain from pasturage amounted to approximately 175 pounds per head per year, most of the gain being made from April to August.

The carrying capacity of improved pastures in the region was high, 155 acres of pasture supplying the 40 steers most of the forage they received.

This study is being continued with 40 steer calves, weighing 415 pounds when delivered to the Station January 27, 1936. The average gain on grazing for these calves from March 31 to November 19, 1936 inclusive, or 231 days, was 155 pounds per head, and again there was no

appreciable response for using lime supplements. These steers will be kept on test for another year.

J. H. Jones, P. R. Johnson, J. M. Jones.

Mineral Requirements of Cattle in the Trans-Pecos Region

Substation No. 9, Balmorhea, Texas

The work at this point was a repetition of the 1934-35 test.

The general object of work at this point has been to determine the most economical fattening ration and method of feeding for the area. A particular study has been made of method of feeding hegari fodder and of the comparative values of hegari fodder and alfalfa hay in fattening rations.

Two lots of 10 steers and one lot of 8 steers were fed a concentrate fattening ration for 168 days and sold. In this group, the lots fed ground hegari fodder made higher gain and finish than the lot fed alfalfa hay as the roughage portion of the ration. Of the two lots fed ground hegari bundles the one which did not receive a lime supplement made slightly higher gain and finish.

Two lots of 10 steers each were fed ground hegari bundles and very limited concentrates for 140 days, after which they were full fed a concentrate ration for 70 days. Gain and finish between these two lots were equal although one lot received 0.10 pound pulverized oyster shell per head daily. As compared to the first group of steers fed for 168 days, these lots made an average of 41 pounds more gain per head and a lower costing gain, but had a lower daily gain and were not quite as desirable in finish.

J. H. Jones, J. J. Bayles, J. M. Jones.

Mineral and Protein Deficiencies in the East Texas Forest Region

East Texas Pasture Investigations, Lufkin, Texas.

The well-bred Hereford heifer calves placed at this Station December 1934 have been continued on the pastures of this Substation.

Maintenance of these cattle was a problem until the spring of 1936 when a 42-acre improved pasture proved sufficient to carry 27 heifers and 1 bull from April to November with very little additional feed. Following this marvelous development of pasturage, the heifers have likewise shown marked improvement and would be a creditable group of cattle in any area, although appearing to be fine in bone.

Beginning February 26, 1936, these heifers were divided into five groups of 5 head each and received by daily drenching these different minerals: cobalt, iron, copper, bone meal, and check (no treatment). The group receiving copper made appreciably more gain (317 pounds per

head) during this period than the other lots (275 pounds); however, the difference at this early date is not great enough to be significant.

J. H. Jones, E. K. Crouch, J. M. Jones.

A Study of Native and Improved Pastures in the Gulf Coast Prairie of Texas

Substation No. 3, Angleton, Texas
(In cooperation with Division of Agronomy)

The same group of 14 steers kept on this Station during 1935 has remained during 1936. Seven steers are grazed on 17 acres of improved permanent pasture and 7 on 17 acres of native pasture. Except that the year was adverse to good grazing conditions and pasturage was scanty, particularly on the native pasture during the midsummer drought, the conditions previously noted obtained this year; viz., that the improved pasture had much greater carrying capacity and was much superior for fattening except for early spring.

Collection of grass samples for analyses was discontinued as it was deemed that sufficient sampling had been done to give an assay of the annual chemical composition including minerals of the various grasses—Bermuda, Dallis, carpet, Angleton, salt grass, and the upland prairie grass, mostly *Andropogon scoparius*. The steers will probably be marketed during the spring of 1937.

R. H. Stansel, E. B. Reynolds, J. H. Jones.

Beef Cattle Feeding Investigations Relating to Mineral Deficiency Studies in Range Beef Cattle Production

(In cooperation with the Divisions of Chemistry and Veterinary Science, and Bureau of Animal Industry, U. S. Department of Agriculture)

Work on this project which became operative in June 1936 consisted of a preliminary survey of the South Texas grazing region in which possible ranch cooperators were visited; the dominant grasses were identified, and some 120 samples of such grasses were collected for analyses. Total and partial analyses have been completed for some 92 samples collected, mostly from Wharton, Jackson, Victoria, Refugio, and Kleberg counties.

These analyses together with analyses of grasses at Angleton, Beeville, Tyler, Lufkin, and Laredo collected previously, afford a considerable amount of data on the chemical and mineral composition of the grasses growing in the South and East Texas region. A rather complete annual assay for chemical composition including mineral content has been made of the important grasses growing on the Angleton Station but such assays are not complete for other points at which sampling has been done.

The grasses from the East, Southeast, and South Central Gulf Coast Region show generally low P_2O_5 content, while the grasses from the

Southwest are generally higher and ordinarily ample in P_2O_5 . Preliminary observations indicate that there is a close relationship between the P_2O_5 content of the grasses and the size and thrift of the cattle.

J. M. Jones, J. H. Jones, W. H. Black.

Feeding Problems Affecting Beef Production

U. S. Experiment Station, Big Spring, Texas

(In cooperation with Bureau of Animal Industry, U. S.
Department of Agriculture.)

The work for 1935-1936 was the same as for 1934-1935 except that in addition to the study of individual feeding as compared to group feeding for fattening and of the relationship of type and individuality of steers to rate and economy of gains, a third objective, the effect of limited versus full-feeding for individuals and groups, was introduced.

As in 1934-1935, group-fed steers consumed a larger amount of concentrates, (12 per cent) but consumed less roughage (4 per cent), while in the previous year they had consumed 11 per cent more roughage. Gain was 7 per cent greater for group-fed steers with practically no difference in cost per cwt. of gain. Group-fed steers had higher finish and a slight advantage in selling price and made more favorable financial return.

Data as to the relationship of type and individuality of steers to rate and economy of gains have not been subjected to analysis. It is, however, increasingly evident that performance of individuals is difficult to predict and that marked differences in gain and economy of gain result between feeder calves of essentially the same breeding, age, and initial weight.

The individuals and group-fed steer calves which were fed only 80 per cent of the ration supplied to the full-fed individuals and groups made 15 per cent less gain but their feed cost per cwt. of gain was 5 per cent less. They lacked high finish, although fed for 210 days, and made decidedly less favorable financial return than the full-fed calves. Their selling price was 4 per cent less, but there might have been more difference except that the market on which they were sold made little distinction in price between medium and good finish.

Rib cuts from three representative animals in each group were submitted to the Rural Home Research Laboratory, where they are being analyzed for nitrogen, fat, and moisture.

J. M. Jones, F. E. Keating, W. H. Black, and J. H. Jones.

Vitamin A Requirements for Beef Cattle and Sheep

Substation No. 7, Spur, Texas

(In cooperation with the Divisions of Chemistry and Veterinary Science,
and Bureau of Animal Industry, U. S. Department of Agriculture)

The object of the work for 1935-1936 was to determine the carotene requirements of fattening beef steers.

Fifty choice quality Hereford yearling steers were used. The steers were first depleted of vitamin A storage by feeding a ration of 12 per cent cottonseed meal and 88 per cent cottonseed hulls. The average time required for depletion was 199 days, although four steers were depleted after 146 days. The steers were considered to be depleted after at last two observations for complete night blindness. One steer was a notable exception, being fed on cottonseed meal and cottonseed hulls only, for 386 days and not becoming night blind. This steer fattened and was adjudged in prime condition of flesh when marketed, but had swellings about the shoulders and was condemned upon slaughter.

In order of depletion the steers, 10 head to a group, were started on varying levels of carotene supplied in alfalfa meal 200, 350, 500, 750, and 2400 micrograms of carotene per cwt. live weight daily. The 200 and 350 levels were soon definitely proved to be too low for normal health and the steers on these levels were raised to 1800 and 1000 levels respectively. Five of the steers on the 500 level were raised to 1250 level.

The 500 level also proved to be too low. These steers remained alive but evidenced symptoms of severe depletion, and after slaughter one steer was found unfit for consumption. The steers on the 750 level remained in fair health, partially recovered their night sight, and made about as much gain as was secured from any of the higher levels of feeding; however they noticeably lacked the liveliness displayed by the group receiving the 2400 level.

The general level of gains was low, 1.37 pounds per head daily for the year's test. On the average, all groups made greater gain before than after depletion, 1.50 and 1.24 pounds respectively, except the group on the 2400 level, and in this group the difference was slight. This occurred despite the ration before depletion consisted only of cottonseed meal and cottonseed hulls, while after depletion the standard ration was 15 per cent cottonseed meal, 35 per cent ground white grain, and 50 per cent cottonseed hulls with carotene allowance supplied by the alfalfa hay in addition.

It is believed that the steers were depleted too greatly before being supplied with carotene, thus causing low gains in the after-depletion, or fattening, period. A lesser stage of depletion will be required in the ensuing work to refine further the requirements of carotene for fattening.

J. H. Jones, R. E. Dickson, J. M. Jones.

Determining Grades and Shrinkages of Texas Wool and Mohair

The purpose of this study is (1) to determine grades and shrinkages of representative wool and mohair samples for the information of producers desirous of further improving their sheep and Angora goat flocks; and (2) to obtain individual grading and scouring records on the fleeces

from Rambouillet sheep and Angora goats used in connection with inheritance studies at the Ranch Experiment Station, Substations No. 6 and No. 16, and the Feeding and Breeding Station. A representative number of the wool fleeces produced by the A. & M. College of Texas and The Texas Technological College flocks have also been graded and scoured for the benefit of animal husbandry students interested in this field of specialization.

Sixteen thousand five hundred and fifty pounds of wool were scoured during the year. A special effort was made to secure representative wool samples from farming areas this year for the purpose of gaining some more definite information regarding shrinkages of fleeces produced under these conditions. Rambouillet fleeces produced under farm conditions in the vicinity of Iowa Park showed a shrinkage of 69 per cent. Likewise, fine wool fleeces produced under somewhat similar conditions in the Lubbock farming area showed a high shrink as compared with those produced under range conditions in the Edwards Plateau area.

One hundred thirty-five representative mohair fleeces, produced by registered Angora goats at the Ranch Experiment Station, showed a shrinkage that ranged from 15 to 29 per cent. The average shrinkage was 17 per cent for bucks and 16 per cent for does in the fall of 1935, as compared with 17 per cent for bucks and 22.5 per cent for does in the spring of 1936.

S. P. Davis, J. M. Jones.

Relation of Age of Animal to Fineness of Wool and Mohair Fiber

Data for wool comparable to that previously published for mohair have been analyzed and are practically ready for publication.

J. M. Jones, B. L. Warwick, S. P. Davis, W. H. Dameron.

ENTOMOLOGY

The Sorghum Worm

Infestations of the sorghum worm, *Celama sorghiella* Riley, were generally lighter and less destructive to grain sorghum crops than in 1935. Although weather conditions were apparently favorable for multiplication of the insect, little or no injury occurred prior to August. However the rate of reproduction increased noticeably during the latter part of the growing season and heavy populations of worms developed in local late-planted crops and in second crops of grain sorghum that remained succulent or attractive as food during September. These late-maturing crops suffered the greatest losses, which in some fields were conservatively estimated to total about 30 per cent of the grain yield. As in previous seasons, no extensive injury by this insect was accomplished prior to August 1, which suggests early planting of grain sorghum crops as an effective measure in minimizing losses in yields that may be produced by this insect.

Hibernation: With the occurrence of cool weather in the fall, sorghum worms seek shelter beneath the leaf sheaths on the stalks where they remain largely inactive until the following spring. On November 29, 1935, 1000 milo stalks from an infested crop were installed in a screened cage situated under open field conditions for detailed records on spring emergence of the moths. Based on samples examined at the time of installation, the number of hibernating worms contained in the caged stalks was estimated at about 5400. The first moth appeared in the cage on March 26, which was one day prior to the beginning of emergence in 1935. Cool and dry weather retarded emergence until the middle of April, after which the moths appeared in larger numbers as a result of more favorable weather conditions. The distribution of total emergence recorded was as follows: March, 0.41 per cent; April, 46.93 per cent; May, 51.74 per cent; and June, 1.00 per cent. The peak or period of maximum emergence occurred during the week beginning May 5. Out of an estimated total of 5400 hibernating worms only 603 individuals, or 11.17 per cent, survived the winter as compared with 10.75 per cent in 1935; 12.57 per cent in 1934; and 17.46 per cent in 1933. The surviving individuals included 311 male and 292 female moths.

Field infestations: Examinations of practically mature crops in local fields during July showed little or no injury as a result of sorghum worm attack. A total of 900 seed-heads in later crops (blooming to dough stage) were examined during the month in six separate fields. About 8 per cent of the heads of grain was infested with an average of one or two worms per head. In August a total of 2200 grain sorghum heads was examined and about 35 per cent showed slight to moderate injury. The maximum worm population averaged about 20 individuals per head. Dry weather during August apparently checked the rate of sorghum worm multiplication, but with the occurrence of ample rainfall in September the infestations in late-planted crops under observation increased to approximately 70 per cent. Counts of the number of worms per seed-head ranged from 0 to 126, and about one-half of the seed kernels were either partially or wholly destroyed. Mature worms were noted behind the leaf sheaths or in winter quarters on October 7, but large numbers of immature individuals continued to feed in late crops for at least two weeks longer.

Parasites: Besides the natural insect enemies mentioned in the previous report, four additional species of hymenopterous parasites were reared in small numbers from the sorghum worm during the latter part of the season. Two of the latter attack the pupal and the others the larval stage of the host. The late seasonal appearance and the limited number of these parasites reared indicate that their value may not be of very great economic importance in checking the development of injurious infestations of sorghum worms.

The study of this insect is being concluded at the end of this year and the data secured during the past four seasons are being prepared for publication as a Station Bulletin.

H. J. Reinhard.

Boll Weevil Hibernation

(In cooperation with the Bureau of Entomology and Plant Quarantine
U. S. Department of Agriculture)

That portion of the overwintering boll weevil population which passes the dormant season successfully constitutes a potential from which injurious infestations may subsequently develop. To determine the survival of the weevil during the winter 1935-1936, ten lots of 500 weevils each were collected in local cotton fields from October 12 to November 23, 1935, and installed in separate cages for detailed records on spring emergence. All hibernation cages were located at College Station under open field conditions and contained Spanish moss as shelter for the insects.

The past practice of beginning the removal of all active weevils on March 1 was discontinued. In the present series of cage experiments this procedure will be delayed until one week after the first young cotton plants appear in local fields. In 1936 the date for commencing the removal of weevils from the cages occurred on March 30.

A total of 82 weevils, or 1.64 per cent of the 5000 individuals installed in the cages, passed the winter successfully. The minimum dormant season temperature was 16 degrees F. recorded in February. The total emergence from hibernation recorded by months was as follows: March, 0.08 per cent; April, 0.40 per cent; May, 0.80 per cent; and June, 0.36 per cent. The rainfall recorded from April to July, inclusive, totaled slightly more than 25 inches and was distributed over 31 days. Under these favorable conditions, the surviving weevils multiplied rapidly and infestations of injurious proportions occurred locally and in other sections of the State.

H. J. Reinhard.

Three thousand weevils again were installed at the Winter Haven Substation, 500 being placed in each of two cages on October 1, November 1, and December 1. Twigs and trash gathered by pack rats constituted the shelter material in one of the two cages, while corn stalks were placed in the other. Beginning March 15, the active weevils were removed from the cages. Survival in the cages in which the weevils were installed October 1 was 0.4 per cent, November 1, 2.8 per cent, and December 1, 1.5 per cent. Twigs and trash or the "rat nest" material was a little more favorable for weevil protection than corn stalks. In the former, 1.8 per cent survived, while from the latter 1.3 per cent emerged. A large majority (91.5 per cent) of the weevils in all cages emerged during the last two weeks of March. None emerged after April 14.

S. E. Jones.

The Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, continued the large-scale experiments in hibernation

and survival of boll weevils in the same manner as in recent years. Thirty-five thousand weevils were collected without difficulty in the fall of 1935 and installed as usual in cages on October 15, November 1, and November 15.

Removal of active weevils from the cages began May 11, 1936, and continued until June 19. The percentages of weevils emerging from the different types of hibernation were as follows:

3.72 per cent from corn stalks in the open.

1.7 per cent from moss in the open.

0.52 per cent from moss in the woods.

0.52 per cent from leaves in the woods.

The survival was greatest among the weevils which were installed November 1. Total emergence in all cages was 2.40 per cent.

R. W. Moreland, Bur. Ent. and Pl. Quar.

Cotton Flea Hopper

The cotton flea hopper, *Psallus seriatus* Reuter, was less injurious in the northern and central portions of the State than in 1935, but in about forty counties south of a line from Houston to Austin and San Antonio, injury was severe. An unusually heavy infestation and considerable damage occurred also in parts of Northwest Texas, particularly in Dickens and Lubbock Counties. Infestation in the Brazos bottom was lighter than usual and in only a few locations were control measures necessary.

Migration: The trap catches of adult flea hoppers for the season showed that no distinct migration occurred in South-central Texas in 1936. Fewer adults were caught than any year since the traps have been in operation, 1931-1936. Ordinarily the largest numbers of adults are caught during June, but when large numbers are taken on the traps in April, severe injury follows, as in 1935. The first adult flea hopper caught in 1936 was on April 10.

J. C. Gaines and F. L. Thomas.

Control: The main work in the flea hopper control program during 1936 consisted in testing the relative effectiveness of sulphur sprays in comparison with sulphur dusts applied so that approximately equal quantities of sulphur were used per acre. While a definite gain results in yield of seed cotton per acre from the use of a wettable sulphur spray, the increase as a result of dusting is so much greater that it more than offsets the extra cost of dusting machinery. These tests were conducted in the black land area near Temple.

T. McGregor and F. F. Bibby.

Two dust mixtures in which two commercial brands of Paris green were used with sulphur in the proportion of 10 per cent Paris green

and 90 per cent sulphur caused definite "burning" of foliage, which developed three days after the applications in the Lower Rio Grande Valley. The dusts were applied at the rate of 15 pounds per acre when dew was present. There was no reduction, however, in the yield of seed cotton per acre. No burning resulted when the dust mixtures were used in the proportion of 5 per cent Paris green and 95 per cent sulphur.

S. W. Clark.

Hibernation: The active stages of the cotton flea hopper die off as the end of the growing season approaches. The eggs, which are laid in various kinds of common weeds during the fall, remain dormant throughout the winter and hatch with the advent of warm weather in the spring. Knowledge concerning the time during which the overwintering eggs hatch and the number of young flea hoppers that emerge is of practical value in anticipating the development of injurious infestations in the early part of the growing season.

Croton capitatus, commonly known as goatweed, is the preferred host plant of the cotton flea hopper, and in regions where it occurs abundantly a large proportion of the insects' eggs is carried through the winter in this plant. To secure detailed records on emergence of young flea hoppers from this host plant, ten separate lots of 100 plants each were collected during the late fall of 1935 in Austin, Burleson, Brazos, Freestone, Grimes, Madison, Waller, and Washington Counties. On February 27, 1936, each lot of host plants was placed in a separate emergence cage at College Station from which the young hoppers could be removed and counted daily after emergence had begun.

The flea hopper eggs in these host plants began to hatch on March 6, and the insects continued to emerge in small numbers during the following four or five weeks which were characterized by unseasonably cool and dry weather. By April 16, only 26 per cent of total emergence was completed as compared with 49 per cent during the previous season. Favorable weather conditions during the latter half of April effected a greatly increased rate of hatching, and nearly 70 per cent of total emergence was completed by the end of this month. In other words, fully two-fifths of the flea hopper eggs hatched from April 16 to 30, inclusive, and approximately one-third after May 1. The percentage of emergence subsequent to April 15 was the largest on record. Although injurious infestations of flea hoppers occurred on cotton in some sections, particularly in South Texas, the insect did not produce extensive losses in counties of South-central Texas. The total number of flea hoppers which hatched per 100 *Croton capitatus* plants averaged 6,031, as compared with 6,025 in 1935; 7,481 in 1934; 5,237 in 1933; and 3,225 in 1932. Last emergence of any insects from the overwintering flea hopper eggs in the caged weeds was recorded on June 8.

Seven lots of 100 *Croton monanthogynus* plants were collected in Bell, Ellis, McLennan, Hill, Dallas, Rockwall, and Collin Counties to determine the importance of this plant as a winter host of the flea hopper in the

blackland section where *Croton capitatus* does not commonly occur. The emergence from the separate installations ranged from 137 to 2,147 flea hoppers and averaged 805 insects per 100 weeds for all the counties included. Other important flea hopper winter host plants, which occur as common weeds in the blackland section, have been mentioned in previous reports.

Emergence from two lots of cotton stalks collected in Burleson County averaged 287 flea hoppers per 100 plants. The period of maximum emergence extended from April 30 to May 8.

Egg parasite: A minute hymenopterous parasite, which attacks and destroys cotton flea hopper eggs, was reared on October 12. The importance of the parasite in checking the development of injurious flea hopper infestations has not been determined. Parasitized hopper eggs were noted in *Croton capitatus* weeds collected in Brazos, Burleson, and Milam Counties. Mr. A. G. Gahan, of the Bureau of Entomology and Plant Quarantine, determined the egg parasite as an undescribed species belonging to the genus *Erythmelus* of the family Mymaridae.

H. J. Reinhard.

Cooperative Work on Cotton Insect Control

Cotton Flea Hopper: Cooperated with the Texas Extension Service by directing the technical work in connection with 55 demonstrations in flea hopper control conducted in 29 counties.

F. L. Thomas.

Pink Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine
U. S. Department of Agriculture)

There was a higher seasonal infestation in the Presidio Valley during 1935 than during 1934. The infestation, however, did not reach the 1932 level. Plowing of the fields was completed much earlier in the winter than normally, and since none of the fields were irrigated following the plowing, this may have contributed to a heavier winter carry-over of worms. Hibernation experiments over a period of years have shown that early winter burial of larvae followed by no winter irrigations tends to increase the survival.

There has been a considerable increase in cotton acreage in adjacent Mexico during recent years, and this no doubt has influenced the infestation on this side to some extent.

Observations of the factors influencing the variations in the intensity of the pink bollworm infestation in individual fields indicated that the heavy infestations were largely confined to the fields with heavy soil types. Late maturing cotton of rank growth also tended to show more severe pink bollworm damage.

Soil examinations showed an abnormally heavy pink bollworm population overwintering in this environment. The increase was attributed mainly to the cool weather that prevailed during the fall months.

Bloom infestation counts during June indicated a much higher overwintering pink bollworm survival in 1936 than in 1934 and 1935.

Hibernation: Soil examinations under plants that had been stripped of all fruiting forms at various intervals during the fall showed that the overwintering worm population hibernating in the soil could be reduced by early maturity of the crop and destruction of the stalks.

Moth emergence from larvae in bolls subjected to various cultural treatments showed a survival of 6.29 per cent in the spring of 1936.

Pink bollworm larvae that had completed their development by feeding in squares and blooms in the late fall were able to survive the winter when buried.

Cultural Control and Field Cleanup: Two winter irrigations following burial were slightly more effective than one winter irrigation. The earlier in the winter the bolls were buried and watered, the lower the survival, and the earlier in the winter the bolls were buried and not watered, the higher the survival.

Tests conducted to determine the influence of the time of an application of a spring irrigation on the time of emergence showed that early spring watering tended to stimulate an early emergence.

In addition to making improvements in the push-type tractor-operated stalk shaver and windrower, a push rake was developed for gathering the cut stalks into large piles for burning. This promises to be practical and effective.

A large screen cage eight feet in height and covering .56 acre has been completed with the aid of funds from the Works Progress Administration. It is to be used in connection with field scale cultural control tests where the factor of moth migration from adjacent untreated areas will be eliminated.

Biological Control: *Microbracon kirkpatricki* Wilk. did not go into a resting stage overwinter in tests at Presidio. It apparently requires the presence of host larvae for continuous breeding. Although large numbers of the parasites have been released at Presidio, no recoveries have been made.

Chelonus blackburni Cameron, also, has been released in large numbers in the Presidio Valley. This parasite, introduced from Hawaii, has been reared in the laboratory on larvae of the Mediterranean flour moth and the Angoumois grain moth.

Laboratory tests have been carried on with the Egyptian strain of *Exeristes roborator* Fab., *Microbracon mellitor* (Say) from Hawaii, and

Elasmus platydræ Ferriere from Egypt. The stock of *Elasmus* did not build up and died after several months' breeding.

Nine varieties of cotton were tested to determine if any showed resistance to pink bollworm attack. All became 100 per cent infested by the end of the growing season. However the tests did reveal that the earliness of maturity might be of importance in obtaining a reduction in the amount of damage caused by the pink bollworm.

Remedial Measures: Seasonal infestation counts indicated that barium fluosilicate and cube'-sulphur used separately as dusts or sprays reduced the worm population. This was more apparent on the plats dusted with barium fluosilicate. Further investigations are necessary to determine the merits of insecticides as a measure of pink bollworm control.

A. J. Chapman, Bur. Ent. and Pl. Quar.

Cotton Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture)

Bollworm injury to cotton was not as widespread throughout the State as in 1935. In those areas, however, where heavy rainfall occurred in May and June, severe injury occurred. Most of the rivers and streams in South Texas overflowed and heavy bollworm injury occurred in the succulent cotton which developed. In the Brazos River bottoms, in the vicinity of College Station, injury continued throughout the summer, with little distinction among broods.

Hibernation and Spring Emergence: It was impossible to carry out these experiments successfully because over 90 per cent of the bollworms collected died before entering the soil to pupate. This was due apparently to a disease which attacked the bollworm larvae maturing in the fall, killing them in large numbers. Hundreds of dead bollworms were observed in the field, and practically all live worms collected died shortly after.

Biological: Bollworm injury to cotton began about a week later than the average date. This was possibly because corn matured later than usual. The moths which develop from worms maturing in corn ears are to a great degree responsible for the infestation of bollworms on cotton.

It was again apparent this year that the highest oviposition was on the most succulent and rapidly growing plants.

Control: Calcium arsenate dust when applied at the beginning of an infestation again proved an effective control for the bollworm, *Heliothis obsoleta* Fab. Satisfactory control of this pest apparently is dependent upon two practices which must be followed (1) The application must be timed so that the dust is on the plants when the young larvae hatch or very soon thereafter; (2) at least eight pounds per acre must be applied

when machinery possessing one nozzle to each row is used, but an airplane application of eight pounds per acre did not control the boll-worm.

R. K. Fletcher and R. W. Moreland, Bur. of Ent. and Pl. Quar.

Thrips on Cotton

Until the latter part of May, dry weather and the large numbers of thrips which were flying gave promise of considerable thrips injury to young cotton in 1936. A week of rainy weather the latter part of May promptly put an end to any question of damage by the flower thrips, *Frankliniella tritici*. The numbers caught on the traps dropped off 65 per cent, and the rapid growth of the young plants soon placed them beyond the stage when an infestation would be particularly injurious.

M. J. Janes.

Minor Cotton Pests

During the season of 1936, *Plusia brassicae* Riley was observed in small numbers "ragging" the leaves of cotton in the Brazos River bottom on a number of plantations. These worms continued to feed on the cotton leaves, in spite of a five-day schedule of calcium arsenate applications that were being applied for boll weevil. Several generations of worms occurred during the season.

A few specimens of *Platynota rostrana* Walker, identified by Mr. A. Busck of the National Museum, were found feeding on cotton during the season of 1936. These tortricid larvae feed on the cotton squares.

J. C. Gaines.

Sulphur as an Insecticide

(In cooperation with Texas Gulf Sulphur Company)

The project on the use of sulphur as an insecticide has been investigated at Substations No. 2, No. 15, and No. 19, at the Laboratory for Truck Crop Insect Investigations, and on farms privately owned in Hidalgo, Burleson, and Bell Counties.

Probably the most important progress in these investigations was the determination that spraying with sulphur for control of the cotton flea hopper, *Psallus seriatus*, was decidedly less effective than dusting with sulphur when the same amount of sulphur, or 15 pounds, was applied to the acre. Many of the farmers in the Blackland region use spray machinery for leafworm control and desire to spray when the flea hopper is injurious.

A calcium arsenate-sulphur mixture applied as a dust is effective for both boll weevils, *Anthonomus grandis*, and flea hoppers, *Psallus seriatus*.

There was no indication that sulphur reacts with calcium arsenate to reduce the effectiveness of the latter as an insecticide. When used in combination for control of boll weevil and flea hopper, it is recommended that a complete dosage of calcium arsenate be used and an equal or larger amount of sulphur be mixed with it, depending on the severity of the infestation of cotton flea hopper.

Conditioned sulphur (99 per cent passing 325 mesh) was effective in controlling the tomato suck fly, *Dicyphus minimus*, during hot weather at Winter Haven, but during cool weather at that location the adults of the insect were not killed, even though heavy applications were made.

Other investigations in which sulphur was used are reported under Truck Crop Insects and in the reports under Substations 2, 15, and 19.

F. L. Thomas et al.

Pecan Insect Investigations

(In cooperation with the School of Agriculture, A. and M. College of Texas)

The infestation of pecan nut case bearer in the vicinity of College Station was so light in 1935 that the greater part of the dormant spraying experimental work was conducted at Navasota. Here there was an infestation of leaf case bearers. Twenty-one trees were selected, from which a considerable number of branches were cut. The leaf case bearer hibernacula were examined on these twigs and the number tabulated. The tabulated material was arranged in four groupings, those containing larvae alive, dead, or parasitized, and those which were empty.

The trees were then sprayed with oil emulsions containing oil concentrations of 4 per cent, 6 per cent, and 8 per cent, after which twigs were again cut from the trees and examined for hibernacula. Eight per cent oil gave adequate control, and there was no burning of the twigs as was the case in 1935.

S. W. Bilsing.

Studies on the Devil's Shoestring, *Tephrosia virginiana* (Linn.), as an Insecticide

(In cooperation with the School of Agriculture, A. and M. College of Texas, and Bureau of Plant Industry, U. S. Department of Agriculture)

Propagation studies have been continued. Planting the seeds directly in the field and simple crown divisions have continued to be successful. However, dividing the crowns into a large number of small cuttings and propagation from stems have been unsatisfactory. It has been learned that seed planted in July directly after ripening readily germinate and the young seedlings grow nicely when shade and moisture

conditions are satisfactory. By planting the seeds in midsummer, it is hoped that the work will be speeded up. Studies on heredity and the influence of environment on toxicity have been continued, but no positive conclusions have been reached.

V. A. Little and G. A. Russell, Bur. Pl. Ind.

Truck Crop Insect Investigations

The work has been conducted at three locations: the Laboratory for Truck Crop Insect Investigations in Galveston County; the Substation 15 in Hidalgo County; and Substation 19 in Dimmit County. Reports of entomological work at the respective substations will be found under Substation numbers.

Turnip louse, (*Rhopalosiphum pseudobrassicae*): The general average effectiveness of the tests shows that the standard spray formula applied with a nozzle producing a flat spray was superior to the spray applied by means of a nozzle producing a cone-shaped spray, and also superior to the rotenone-pyrethrum-sulphur combination in dust form.

The standard nicotine sulphate-penetrol spray was more effective than the dust mixtures for a week or ten days after the applications were made.

Cabbage looper, (*Plusia brassicae*): Results in two series of experiments indicated that there was very little difference between sulphur and Fuller's earth when mixed with cube'. Dutox mixed with Fuller's earth 1-2 did not seem to be effective in controlling cabbage loopers.

Empoasca fabae. Both sulphur alone and a sulphur-pyrethrum mixture containing .075 per cent pyrethrins gave good results in controlling the bean leaf hopper and produced an increase over the untreated area of approximately 20 bushels of beans per acre.

Diabrotica balteata, the belted cucumber beetle, was poorly controlled on beans by sulphur alone, but the pyrethrum-sulphur mixture gave fair results in reducing a comparatively light infestation. This insect is coming to be recognized as a pest of beans that causes considerable injury in South Texas.

J. N. Roney.

Apiary Inspection, 1935-1936

An excellent year was experienced by the Inspection Service.

Two inspectors in a State car visited 738 beekeepers in 76 counties. They travelled 18,181 miles and inspected 39,152 colonies of bees.

Queenbreeders' certificates were granted to 38 queen breeders and package bee shippers.

American foulbrood was found in .87 per cent or 340 of the 39,152 colonies which were examined. C. E. Heard and C. J. Burgin.

For other entomological investigations, see reports of Substations 2, 15, and 19, respectively.

AGRONOMY

Investigations and Oat Improvement

(In cooperation with Bureau of Plant Industry, U. S. Department of Agriculture)

The work under this project is done chiefly at Substation No. 6, Denton, and the results are given in the report of that station.

P. C. Mangelsdorf.

Fertilizers for Field Crops

The main objective of this work is to determine the fertilizer requirements of the main field crops on the more important soil groups in the State. At the present time the work is being conducted at the Main Station at College Station; at Substation No. 2, Tyler; at Substation No. 3, Angleton; and at Substation No. 6, Denton. Cotton, corn, oats, and wheat are the crops used in these studies. Only a brief summary of the work is given here since a more detailed account of the results will be given in the reports of those substations.

Cotton is included in the experiment at all four points. In 1936 the conditions were not favorable, and the yield of cotton was considerably below the average.

At College Station on Lufkin fine sandy loam soil the yields of the individual treatments ranged in 1936 from 321 pounds per acre for the treatment of 12 tons of manure and 400 pounds of superphosphate, to 103 pounds for the 4-12-0 fertilizer. The average yields during the nine years of the experiment indicate that this soil is more deficient in phosphoric acid and potash than in nitrogen. During this period the 4-12-4 fertilizer used at the rate of 400 pounds per acre produced an average yield of 312 pounds of lint per acre, while the 4-0-4 fertilizer (which contains no phosphoric acid) produced only 260 pounds. This is a difference of 52 pounds per acre which is strongly significant, indicating that phosphoric acid is deficient in the Lufkin soils. The 4-12-0 fertilizer (which does not contain potash) made an average yield of 254 pounds of lint per acre, or 58 pounds less than the 4-12-4 fertilizer. All of the fertilizer treatments produced significantly larger average yields than the soil which received no fertilizer. The results indicate that the use of 0-12-4 or 4-12-4 fertilizers at the rate of 200 to 400 pounds per acre is satisfactory for cotton on Lufkin fine sandy loam soil.

The work over a period of years at Substation No. 2, Tyler, has indicated that the use of 200 to 400 pounds of a 4-8-4 or 4-6-4 fertilizer on cotton gives more profitable results than fertilizers with higher proportion of phosphoric acid.

On the Lake Charles clay soil at Substation No. 3, Angleton, in the Gulf Coast Prairie, applications of phosphatic fertilizers have produced larger increases in yield of cotton than applications of nitrogen or potash. Thus for the five years 1930-1935, the application of 16 pounds of phosphoric acid in superphosphate produced an average yield of 306 pounds of lint per acre, which was 32 pounds more than the yield of the untreated soil. Further, the 4-12-4 fertilizer made an average yield of 355 pounds per acre, as compared with a yield of 299 pounds for the 4-0-4 fertilizer, which contains no phosphoric acid. The yields of cotton gradually increased from 320 pounds to 451 pounds of lint per acre as the rate of application of the 4-12-4 fertilizer was increased from 200 to 1000 pounds per acre. The results obtained at Angleton indicate that the use of 100 pounds of superphosphate or 200 to 600 pounds of 4-8-0 or 4-10-0, or 150 to 200 pounds of 16-20-0 per acre is good fertilizer practice for cotton on the Lake Charles clay soil.

Satisfactory results were not obtained on the San Saba clay at Substation No. 6, Denton, in 1936 on account of the long period of dry weather in the spring, resulting in very little response to fertilizers. The results obtained during the period from 1928-1935, however, show that the soil responds more readily to applications of phosphoric acid than to applications of nitrogen or potash. For example, the 4-8-4 fertilizer made an average yield of 307 pounds of lint per acre, while the 4-0-4 fertilizer (which contains no phosphoric acid) produced 259 pounds. This is a difference of 48 pounds of lint, which is no doubt due to the phosphoric acid. The results indicate that the use of 100 pounds of superphosphate will probably supply the deficiency of phosphoric acid in the soil.

Corn is included in the fertilizer work at the four points, College Station, Tyler, Angleton, and Denton.

The fertilizer work with corn at College Station, located on Lufkin fine sandy loam, in 1936 was much more satisfactory than the results obtained with fertilizers on cotton. The yield of corn ranged from 24.3 bushels per acre for the 0-12-4 fertilizer to 38.2 bushels for the treatment consisting of 12 tons of manure and 400 pounds of superphosphate. During the last nine years 16 of the 17 fertilizer treatments produced significantly higher yields than the untreated soil. The treatment of 12 tons of manure and 400 pounds of superphosphate made the largest average yield, 30.7 bushels per acre, or 9.5 bushels more than the unfertilized soil. Although phosphoric acid has given larger average increases in yield than either nitrogen or potash, none of the fertilizer treatments used seemed to give very profitable returns.

The results with fertilizers for corn at Tyler indicate that the soils are deficient in both nitrogen and phosphoric acid. However the use of complete fertilizers has not been profitable, probably because the acre value of the corn crop has been low as compared with cotton. The results indicate further that the application of 100 to 150 pounds of nitrate of soda or sulphate of ammonia or equivalent amounts of nitrogen in other suitable materials is satisfactory for corn, when the corn follows a crop that has received moderate amounts of complete fertilizer.

The Lake Charles clay soil at Angleton is deficient chiefly in phosphoric acid and nitrogen, as shown by the response of fertilizers to both corn and cotton. The corn crop, however, responds more readily to applications of nitrogen than to applications of phosphoric acid. For instance, during the period of 1930-1935 the average yield of corn gradually increased from 30.2 to 38.8 bushels per acre as the percentage of nitrogen was increased from nothing in the 0-12-4 fertilizer to 8 per cent in the 8-12-4 fertilizer. Similar increases in the amount of phosphoric acid produced only slight and insignificant increases in the yield of corn. Further, the yield gradually increased from 31.4 to 41.7 bushels per acre as the rate of the 4-12-4 fertilizer was increased from 200 to 1000 pounds per acre. The results indicate that the use of a fertilizer containing both nitrogen and phosphoric acid should be used for corn, and that 200 to 400 pounds of 4-8-0 or 150 pounds of 16-20-0 should be satisfactory for corn on the Lake Charles soils.

As stated previously, the dry weather in the spring of 1936 was not favorable for fertilizers at Denton, and practically no response was obtained from the use of fertilizers on corn. Somewhat similar results, however, have been obtained during the last eight years. During this period the unfertilized soil and the soil on plats that received different fertilizer treatments produced practically the same yield.

Oats have been included in the fertilizer test only at College Station. During the last nine years the fertilizers have produced some increases in yield, but not large enough to pay for the cost of fertilizers. Some of the heavy applications have produced large vegetative growth, which is conducive to lodging.

Wheat is included in the fertilizer work at Denton, where it is grown in rotation with corn and cotton. Fertilizers gave very little response in 1936 and the wheat winter killed in 1935. During the seven years 1928-1934, the 4-12-4 fertilizer applied at the rate of 600 pounds per acre made the highest average yield, 35.4 bushels per acre. So far the fertilizer treatments used have not returned a profit above the cost of fertilizers. In the fall of 1936 the work was revised by using small amounts of superphosphate applied in the drill with the seed in an attempt to develop a profitable fertilizer practice for wheat.

E. B. Reynolds.

Rotation and Soil Improvement Investigations

The main object of these studies is to develop suitable cropping systems, including soil-improving and soil-conserving crops, for different regions of the State. The work is being done mostly at College Station, Angleton, Denton, Lubbock, and Spur.

The work at the Main Station, College Station, has been carried on since 1914. It consists of a four-year rotation of cotton, cowpeas, corn, and oats, and continuous cotton and continuous corn. These crops each year receive the following treatments: superphosphate alone, with cottonseed meal, and with manure; rock phosphate alone and with manure; and manure alone. The results obtained during the period 1914 to 1927 were published in Bulletin No. 390. The yields of cotton in 1936, especially the cotton grown in rotation, were considerably below the average for the 23 years. The treatment of 4 tons of manure made the largest yield of rotated cotton, 183 pounds of lint per acre in 1936. In continuous cotton, however, the treatment of 4 tons of manure and 107 pounds of rock phosphate produced the largest yield, 248 pounds of lint. During the last few years nut grass has been spreading gradually on the land where the crops are grown in rotation. As a result, smaller yields have been obtained with rotated cotton than with continuous cotton. (So far no practical and efficient method of eradicating or controlling nut grass has been developed.) In 1936 the treatment of 4 tons of manure and 200 pounds of superphosphate per acre produced the largest yield in both rotated and continuous corn, 27.1 and 16.3 bushels per acre, respectively. During the 23 years of the experiment, the manure produced the largest average yield of corn in rotation (24.7 bushels), while the treatment of manure and superphosphate made the largest average yield of corn grown continuously on the same land (17 bushels). For the 23 years rotated corn as an average of all the treatments made an average yield of 20.7 bushels per acre as compared with 13.8 bushels for the continuous corn. This is a gain of 6.9 bushels, or 30 per cent, in favor of corn grown in rotation.

E. B. Reynolds.

In the work at Spur, the rotation of cotton and grain sorghum made the largest average yield of cotton, 233 pounds of lint per acre, during the last 10 years. Cotton grown on the same land every year made the lowest average yield, 168 pounds per acre, which was 55 pounds less than the yield of cotton alternating with grain sorghum. The largest average yield of grain sorghum, 29.2 bushels, was obtained from the rotation of grain sorghum, green manure (sorgo), and cotton. In a comparison of cowpeas and sorgo for green-manure crops, cowpeas plowed under produced slightly, but not significantly, larger yields of both cotton and grain sorghum than sorgo plowed under.

E. B. Reynolds, R. E. Dickson.

At the Lubbock Station, manured cotton after fallow made the largest average yield, 301 pounds per acre, during the 23 years 1914-1935. Cotton following grain sorghum returned the lowest yield, 234 pounds per acre, or 67 pounds less than the yield of manured cotton after fallow. The largest average yield of grain sorghum, 31.3 bushels, was produced in the rotation of cotton, fallow, and grain sorghum, manured. This yield was 9.0 bushels, or 40 per cent, more than the lowest yield 22.3 bushels, which was obtained where grain sorghum followed manured cotton. In a complete statistical analysis of the data obtained during the 23 years 1914-1935, it was shown that a difference of 3.7 bushels per acre between the average yield of sorghum from any pair of rotations constituted a significant difference.

E. B. Reynolds, D. L. Jones.

Green Manures for Soil Improvement

This work on green manures is being conducted on the Main Station Farm, College Station, to determine the value of hairy vetch for soil improvement. The vetch is planted in the fall and plowed under in the spring. Cotton follows on the land and the yield of cotton is obtained in order to determine the effect of plowing under vetch on the yield of cotton. In 1936 the test was damaged severely by the heavy rains soon after planting and by the extreme drought during the summer. The untreated soil produced 119 pounds of lint per acre, the soil on which the vetch was plowed produced 222 pounds, and the 4-8-4 fertilizer produced 221 pounds. In 1935 plowing under vetch produced a yield of 313 pounds of lint per acre, which was 66 pounds of lint, or 27 per cent, more than the untreated soil.

E. B. Reynolds.

Comparison of Nitrogen Fertilizer Materials

The main object of this study is to determine the relative merits and efficiency of various nitrogenous materials as fertilizers for cotton. Among the materials included are nitrate of soda, sulphate of ammonia, calcium cyanamid, cal-nitro, urea, and calcium nitrate. A 4-8-6 fertilizer was used at the rate of 400 pounds per acre in which the nitrogen was supplied in these materials. The work has been conducted at College Station. In 1936 the test was a failure on account of the long period of wet weather just after the cotton was planted and on account of the extreme drought in the summer. During the five years 1931-1935, however, no significant differences in yield of cotton were obtained from the several sources of nitrogen. Further, all of the nitrogen fertilizers produced significantly larger yields than the unfertilized soil.

E. B. Reynolds.

Polyhalite as a Source of Potash for Fertilizers

This work is being conducted at College Station to determine the value of polyhalite as a potash fertilizer material. Two kinds of polyhalite, red polyhalite and white polyhalite, and muriate of potash are compared by using a 4-8-6 fertilizer at 400 pounds per acre in which equal amounts of potash (K_2O) are furnished in these materials. In 1936 the test, which was conducted with cotton, was a failure on account of continued heavy rains just after the cotton was planted. The results obtained in 1933 and 1935, however, indicate that the potash in polyhalite is as readily available to cotton as the potash in muriate of potash.

E. B. Reynolds.

Inheritance in Cotton

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

The object of this project is to study the inheritance and linkage relations of various characters in cotton as a basis for further improvement of the crop. The results of this study will be used in the breeding work to improve the present varieties through hybridization, backcrossing, and selection.

New intervarietal and interspecies crosses have been made to study the inheritance and linkage of a number of characters. From these crosses new synthetic lines are being developed which have various combinations of characters, the interrelationships of which have not previously been determined. The work at present includes studies on plant type, stem color, leaf shape and color, leaf gland and vein color, callus color, petal color, petal spot size and color, anther and pollen color, boll size, boll surface and suture, seed shape and covering, lint color, and the abundance, length, and fineness of the lint in relation to its spinning value.

Under a cooperative agreement between the Texas Station and the Bureau of Plant Industry, U. S. Department of Agriculture, T. R. Richmond, Assistant Agronomist, was transferred to College Station in the spring of 1936, to cooperate in the cotton genetics project. During the year more than 2000 crosses were made and 176 progenies grown, representing nine different characters. A number of new types and synthetic lines obtained through the Bureau of Plant Industry have been assembled for use in these studies.

A cooperative project to study the inheritance of fiber fineness was initiated during the year with the Bureau of Plant Industry. Since it has been found that fineness of fiber has a close relationship to the spinning properties of cotton, the project has important economic possibilities and offers opportunity to enhance the value of the crop

through the development and general use of higher yielding varieties possessing the desired fineness of fiber. A number of crosses were made between fine-fibered types and productive strains with coarse fibers, using the Hopi variety obtained from northern Arizona as the principal fine-fibered parent in the crosses. The F_1 , F_2 , and subsequent generations will be studied to determine the mode of inheritance of fiber fineness. A system of parallel backcrossing to both parental lines, known as convergent improvement, is being used with the view of isolating fine-fibered strains with other desirable qualities.

The study of the effect of leaf color and shape on yield was continued and the second backcross generation grown. The purpose of the study is to isolate lines through repeated selective backcrosses and genotypic tests of progenies that differ only by a single gene in the various gradations of leaf color and shape, and to determine the effect of these on yield. Part of this study is related to the work of breeding types of cotton for mechanical harvesting, in which an attempt is being made to develop higher yielding varieties with smaller leaf area, more determinate fruiting habit, and more compact plant type, than found in ordinary varieties.

In the F_2 of the cross Lightning Express X Purpurascens, preliminary observations indicate that the same gene is responsible for the red color in the leaf blade, the leaf vein, and the leaf vein gland. In this cross, the hirsuteness, or hairiness, of the plant showed a continuous gradation, ranging from an almost glabrous, or smooth condition, to a densely hirsute condition. Further studies will be made to determine the factors responsible for hairiness in cotton, the inheritance of which now appears to be complex. Hairiness is of considerable importance from the standpoint of insect control, since it has been found that plants with a high degree of hairiness retain a larger amount of the poison dusted on the plants for insect control. Breeding work is under way to develop high-yielding types with a high degree of hairiness by crossing upland varieties which possess hairiness with other types, some of which are upland X Egyptian segregates that do not exhibit possible latent hairiness until such cross is made. Certain of these crosses give hybrids that are more hairy than either parent.

In the various crosses involving a study of leaf shape, lint color, leaf color, pollen color, petal color, and seed fuzziness in various character combinations, classification was made in the field during 1936, and the F_2 and backcross segregation gave the expected monohybrid ratios, which is consistent with the findings of previous workers. The analysis of other characters being studied in connection with those just mentioned is now being made. When this work is completed the combined data will be examined for possible linkage relationships.

Selections have been made in several lines, in which periods of partial sterility of the pollen have been observed, for use in connection

with studies on hybrid vigor and on the practical utilization of hybrid vigor in cotton improvement.

The greenhouse is used during the winter for growing an additional generation of several crosses and of some of the more promising progenies from material grown in the field during the previous season.

The Division of Rural Home Research and the Division of Agronomy are cooperating in a study on the inheritance of the physical properties of the cotton fiber. The parents, F_1 , F_2 , and backcross generations of crosses between Lightning Express with long fine lint and Half and Half with short coarse lint, were grown in 1935, and selected samples of lint from these progenies are now being analyzed.

D. T. Killough and T. R. Richmond, Bur. Pl. Ind.

Cotton Variety Tests

Tests with varieties of cotton were conducted at the Main Station and at the substations during the year. In general the varieties that have been developed in Texas continue to give better results at most of the stations than varieties from other states. Some of the longer staple strains, however, such as Delfos, Missdel, Delta and Pine Land 11, and Stoneville, are well suited to the more humid part of the Gulf Coast Prairie, to alluvial soils, and to the areas where cotton is grown under irrigation.

In a cooperative variety test conducted on the Chance plantation on alluvial soils along the Brazos River near College Station, the longer staple varieties, Acala, Missdel 5, and Delfos 2323-130, were the most profitable. The latter strain is a new and promising dwarf type which is extremely early in maturing.

Acala continues to be one of the best varieties in the tests at Temple and Greenville, in the central and northern parts of the Blackland belt. The earlier maturing strains of the Mebane Triumph type are well adapted to the western part of the state. Mebane, New Boykin, Ferguson 406, Watson, Cliett, Harper, Qualla, and Lone Star and its related strains produce good tenderable staple and have a wide range of adaptation in the state. Several strains developed by the Texas Station, including Startex 619, Mebane 4120-140 and 141, and Mebane 804-50 have made a good showing in widely separated tests.

Although Half and Half has been a high-yielding variety at several of the stations, it frequently produces short and untenderable staple.

D. T. Killough.

Time and Method of Intertillage

At the present time this project is being conducted at Substation No. 7, Spur, and the results of the work are given in the report of that substation.

E. B. Reynolds.

Time and Method of Seed-Bed Preparation

This project is being carried at Substation No. 8, Lubbock, and a detailed statement of the results is given in the report of that substation.

E. B. Reynolds.

Cotton Improvement

The purpose of this work is to develop higher-yielding varieties of good quality staple for given regions of the State. Line breeding and hybridization, followed by backcrossing and inbreeding, are being employed in the cotton improvement work.

Startex 619, a selection from Lone Star, was one of the highest-yielding varieties in the tests at College Station during the 6 years 1931-1936. Mebane 804-50, an inbred strain developed at the Beeville Station, made the highest average yield in the test at that station during the last five years. This selection also has been among the high-yielding varieties in the tests at Chillicothe, Temple, Angleton, and College Station. Inbred strains of Mebane 804 produced significantly higher yields than the parent at the Angleton Station. Strains of Mebane 4120 developed at the Chillicothe Station made the highest average yield in the test at that point during the period 1930-1935. At Denton Sunshine selection 137-5 made the largest yield in the test for the last three years. The inbreeding work at Angleton and Denton was continued during 1936, and several promising lines, which are quite uniform in length of lint and productive, have been isolated.

In the breeding work at Nacogdoches the objective is to combine the good staple and boll qualities of Lone Star with the high yield, high percentage of lint, and earliness of Half and Half with the view of developing a better cotton for the region. The sixth generation of the crosses between these two varieties was grown in 1936. The 62 hybrid strains included in this work have been inbred for four years, and a number of them are showing definite superiority over the parents.

Seed of the improved strains developed by the Experiment Station are distributed to farmers through county agents and vocational teachers in different parts of the State in order to give them a wider and more comprehensive test. The proved superior strains are also put into channels of commercial production through Texas certified seed growers and others.

D. T. Killough.

Rate and Distribution of Seed and Time of Thinning Cotton

The object of this work is to find the best spacing of the cotton plants in the row, the distance between rows, and the best time of thinning. The results of the work up to 1926 were published in Bulletin 340. The

work, however, was continued at Substation No. 7, Spur; Substation No. 8, Lubbock; and at Substation No. 12, Chillicothe. The results at these points will be given in the reports of those substations.

In 1936 a new phase of the work was begun at College Station in which the object is to determine the best spacing of plants at different levels of fertility. Three spacings, 12, 18, and 24 inches, were used on unfertilized land and on land that received 400 pounds and 800 pounds of a 4-8-4 fertilizer, respectively. Although the year was quite unfavorable for cotton production, some noticeable differences were observed in the yield of cotton from the three spacings and in the yield from the fertilizer treatments. On the untreated soil the 12-inch spacing made a yield of 253 pounds of seed cotton per acre, which was 90 pounds more than the yield of the 24-inch spacing. No significant differences in yield of the spacings were observed on the soil that received 400 pounds of a 4-8-4 fertilizer. Where 800 pounds of this fertilizer was applied, the 12-inch spacing produced 543 pounds of seed cotton per acre; the 18-inch spacing, 480 pounds; and the 24-inch spacing, 438 pounds.

E. B. Reynolds.

Study and Improvement of the Peanut

This work includes tests with varieties of peanuts, breeding and selection tests, and tests with fertilizers at the Main Station Farm, College Station. A statement of the results is given in the report of the Main Station Agronomy Farm.

G. T. McNess.

Rice Improvement and Methods of Production

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

This project embraces several phases of rice culture: (a) trials of strains and varieties of rice, (b) hybridization and selection, (c) genetic studies to determine the mode of inheritance of characters in rice, (d) studies on plat technique for rice, (e) trials with fertilizers, and (f) rotations of crops as a means of controlling weeds and increasing the yield of rice. The work is conducted at Substation No. 4, Beaumont, and the results are given in the report of that station.

E. B. Reynolds, R. H. Wyche, H. M. Beachell, Bur. Pl. Ind.

Wheat Breeding

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

Most of the work carried under this project is done at Denton, and the results are given in the report of Substation No. 6.

P. C. Mangelsdorf.

Run-Off Water Losses in Relation to Crop Production

(In cooperation with the Soil Conservation Service,
U. S. Department of Agriculture.)

The main purpose of this project, which has been conducted at substation No. 7, Spur, since 1926, is to study the factors affecting run-off and soil erosion in relation to crop production. A statement of the results obtained in 1936 and in previous years will be found in the report of Substation No. 7, Spur.

R. E. Dickson, B. C. Langley, C. E. Fisher.

Inheritance and Improvement in Corn

Breeding work on the development of yellow-seeded sweet corn varieties is progressing satisfactorily. Mosshart Sugar, a yellow-seeded variety developed from Mosshart Yellow Dent, will be distributed in a preliminary way in 1937. Some very satisfactory yellow-seeded strains of Surcropper Sugar have been isolated which are being recombined to produce a new variety. Yellow Country Gentleman, known as Golden Colonel, has been crossed with Mosshart Sugar and back-crossed to Golden Colonel in the greenhouse to produce a yellow-seeded Country Gentleman type adapted to the South. Purdue 39, one of the best inbred strains of sweet corn ever developed, but one which is not now adapted to Texas conditions, was crossed in the summer of 1936 with Mosshart Sugar, Yellow Surcropper Sugar, Yellow Hastings Sugar, and several other yellow sweet corn strains. All hybrids were back-crossed in the greenhouse in December to Purdue 39 in an attempt to isolate new strains having most of the present characteristics of Purdue 39 plus enough genes from Texas varieties to make the new strains adapted to Texas conditions.

The new type of sugary which was isolated from Surcropper field corn, and which has been mentioned in previous annual reports under the name "amylaceous sugary," is dependent for its inheritance upon two genes, one of which *su am*, is allelomorphic to ordinary sugary. Since the other gene *du* has the ability to convert a type that is almost starchy to one that is intermediate between starchy and true sugary, it was thought that this gene might convert true sugary to a "super-sugary." This has proven to be the case. Chemical analyses of comparable samples show starchy, amylaceous sugary, true sugary, and "super-sugary" to have 13.7, 32.9, 48.7, and 62.6 per cent of sugar respectively. Whether the additional increase in sugar content will bring about a corresponding increase in table quality remains to be determined. Surcropper Sugar is being converted to "super-sugary" so that a direct comparison of this new type can be made with ordinary sugary.

The new yellow field corn varieties, Yellow Surcropper, Golden Thomas, and Yellow Tuxpan, which were distributed for the first time in 1936, apparently proved quite satisfactory to growers, and a much wider distri-

bution is anticipated for 1937. Golden June is being distributed this season for the first time and Golden Prolific should be available for distribution in 1938. The color of these new varieties, which has not been entirely satisfactory, is responding readily to selection. Yellow Surcropper, which had 3.6 parts per million of carotene in 1935, has been raised to 5.2 parts by one year of selection. Golden Thomas, with about 4.0 parts in 1934, was raised to 6.5 parts in 1935 and 7.8 parts in 1936, and is now richer in carotene and higher in vitamin potency than ordinary yellow dent corn, which has about 6.5 parts per million of carotene.

Testing of inbred strains in top crosses has been continued at Beeville, Angleton, Denton, Temple, Nacogdoches, and the Main Station. Approximately 330 top crosses on Surcropper, Thomas, Tuxpan, and Hastings' Prolific were tested in four replications. Results at Temple and College Station were particularly outstanding. At Temple a cross of Surcropper x 123 B made a yield of 40.6 bushels per acre as compared to 30.8 bushels for Surcropper and 21.1 bushels for yellow dent. At College Station a cross of Surcropper x 132A made a yield of 41.9 bushels as compared to 28.4 bushels for Surcropper and 24.9 bushels for yellow dent. Testing of inbreds has now proceeded for a sufficient length of time to identify the better strains, and several of these are being increased so that a seed supply will be available as soon as additional tests have shown the best hybrid combinations available.

P. C. Mangelsdorf.

Pasture Improvement for East Texas

Work under this project is being conducted at Substation No. 2, Tyler; Substation No. 4, Beaumont; Substation No. 11, Nacogdoches; and at Lufkin, Texas. The main purpose of the work is to develop suitable ways of establishing, improving, and managing pastures, both from the standpoint of pasture and livestock to obtain maximum production of pasturage.

Results at Tyler. The work includes (a) mowing to control weeds and other undesirable growth, (b) methods of establishing, or starting, improved pastures, and (c) the introduction and testing of new pasture and forage plants. In the work done so far, mowing has been one of the best ways to improve pastures, especially by destroying weeds and sprouts. Plowing and disking have been effective in establishing stands of Dallis grass and lespedeza in old pastures. Lespedeza sericea, a perennial lespedeza, has been established in a permanent Bermuda grass pasture on the station farm.

E. B. Reynolds, P. R. Johnson.

Results at Nacogdoches. The pasture work is concerned mainly with the establishment of adapted legumes and grasses on unimproved pasture. Successful seedings of lespedeza and white clover have been made on a

pasture consisting mostly of Bermuda and carpet grasses. The carrying capacity of the pasture has been increased greatly, although no exact data are available on this point.

H. F. Morris.

Results at Beaumont. Studies were begun in 1935 to determine the effect of fertilizers on the yield and chemical composition (feeding value) of pasture herbage. The soils of the region are lacking in phosphorus, which is one of the important constituents of the muscles and bones of animals. It was thought that the application of phosphorus in the form of superphosphate and of other fertilizers might increase the phosphorus and nitrogen content, yield, and feeding value of pasture herbage. In 1935 the soil treated with 100 pounds of nitrate of soda per acre produced the largest average yield, 2919 pounds of air-dry forage, which was 817 pounds more than the yield of the unfertilized soil. No doubt this gain in yield was profitable, since it produced about three dollars' worth of forage for each dollar invested in fertilizer.

The use of lime at the rate of one ton per acre at Beaumont increased the yield of pasture forage about 6 per cent, which probably was not profitable.

Samples of herbage have been taken for chemical analysis to determine the effect of applying fertilizers on the chemical composition of the herbage, but the analysis has not been completed.

E. B. Reynolds, R. H. Wyche.

Results at Lufkin. In the pasture work at Lufkin emphasis has been placed upon the development of good improved pastures, the effect of fertilizers on yield and feeding value of pasture herbage, the introduction and testing of new pasture plants, and the management of pastures to get the largest amount of grazing and still keep the pasture in a highly productive condition.

During the last two years an excellent improved pasture of about 42 acres has been established on the station farm at Lufkin. This pasture is divided into eight small pastures, each of which originally was seeded to different pasture mixtures. Now, however, all of these small pastures consist largely of Bermuda, carpet, and Dallis grasses with mixtures of several varieties of lespedeza and white clover. Carpet grass and common (Japan) lespedeza furnish most of the grazing during the growing season. In the early spring, from March to May, however, white clover, hop clover, and Italian rye grass constitute the bulk of the grazing. In 1936 this 42-acre pasture had a carrying capacity of 1.5 acres per cow for the months of March to December, a period of 260 days, as compared with about 20 acres per cow, commonly estimated for average native pasture of the region.

Samples of forage for chemical analysis, representing as nearly as possible the forage being eaten by the cattle, were taken daily from the pasture on which the cattle were grazing. The analysis of these samples is not complete, and consequently the results are not available for this

report. Samples taken from this improved pasture in 1935, however, contained on the average 8.7 per cent of protein, with a range of 5.91 to 11.6 per cent. Samples of herbage from average pastures of the region contained 5.12 per cent protein. The herbage from the improved pastures contained .48 per cent of phosphoric acid and .76 per cent of lime, while unimproved pasture contained .34 per cent phosphoric acid and .25 per cent lime.

In the work to determine the effect of fertilizers on yield and chemical composition of pasture herbage, the use of 100 pounds of nitrate of soda per acre produced a gain of 900 pounds of green forage per acre in 27 days; 118 pounds of 34 per cent superphosphate, 500 pounds gain; and a combination of nitrate of soda and superphosphate, 700 pounds gain. Samples of forage were taken for chemical analyses, but the analytical work has not been completed.

So far about 50 species of pasture plants, some of which grow locally, have been assembled and tested in the nursery or introduction garden. The purpose of this part of the work is to find grasses and other plants that are better for pasture and forage than most of those in common use in the region. Among those showing considerable promise are the woolly finger grasses, Saint Augustine grass, centipede grass, buffalo grass, *Paspalum conjugatum*, and two or three species of *Cynodon* (relatives of Bermuda grass).

Studies in pasture management at Lufkin indicate that mowing is essential in establishing improved pastures because it aids in the control of weeds and other undesirable growth, such as sassafras and persimmon sprouts. Controlled grazing to provide succulent grazing, whenever practicable, mowing to control weeds, and making hay from any excess pasture herbage, seem to be good pasture management for the region.

E. B. Reynolds, E. K. Crouch.

The Genetic and Cytological Relationship Between *Zea*, *Tripsacum*, and *Euchlaena*

(In cooperation with the School of Arts and Sciences,
A. & M. College of Texas.)

Further studies on a stock which carries a *Tripsacum* chromosome bearing the allelomorph of sugary indicate that this chromosome pairs regularly with chromosome No. 1 of *Zea*. Pairing is never complete and sometimes one end of chromosome No. 1 is involved, sometimes the other.

Tripsacum latifolium, a tetraploid species from Guatemala, when crossed with a diploid form of *T. dactyloides* from Texas, produces a triploid hybrid in which there is little, if any, association between the *latifolium* and *dactyloides* chromosomes. This indicates the possibility of crossing tetra-

ploid *latifolium* with tetraploid *dactyloides* to produce a true breeding amphidiploid. Crosses of these forms are now being made.

P. C. Mangelsdorf and R. G. Reeves.

Fertilizer Experiments in the Control of Root Rot

Work on this project was not carried in 1936. The results obtained in 1930, 1931, and 1932 show that the fertilizers used, 4-8-4, 4-8-0, 6-12-0, and 4-0-0, had no appreciable effect on the root-rot disease. The fertilizers, however, produced significant increases in the yield of cotton. The results of these studies have been reported in the Journal of the American Society of Agronomy, Vol. 26: 313-318 (1934).

H. E. Rea.

Mechanical Harvesting of Cotton

The project is conducted jointly by the Division of Agricultural Engineering and the Division of Agronomy. The agronomic phases of the work reported here consist chiefly of studies to determine the adaptability of varieties to mechanical harvesting and to develop a variety or varieties better adapted to mechanical harvesting than the commonly grown varieties.

Breeding work to improve the yield, percentage of lint, and boll qualities of Ducona was continued at College Station and Lubbock in 1936. Ducona, although lacking in the qualities just mentioned, has proved well adapted to harvesting by machinery, due largely to its cluster boll type, short fruiting branches, restricted vegetative growth, and earliness of maturity. During the year additional crosses were made between Ducona and other varieties having the desired characters which Ducona lacks. The resulting hybrid lines will be backcrossed and inbred to obtain high-yielding strains uniform in type. One of the objectives in this work has been to reduce the leaf area on the plant without affecting the yield so that less leaf trash will be harvested. The crosses with okra leaf Acala are promising, and increase plantings of the better types will be made for harvesting trials as rapidly as the supply of seed will permit. Some of these progenies are being grown in the greenhouse during the winter.

The short fruiting branch, which is conducive to the efficient operation of the harvester, is being introduced into several high-yielding varieties with normal fruiting branch. This is being accomplished by means of repeated backcrossing and progeny testing to insure the retention of the short fruiting branch character, which is recessive.

In the work at Lubbock, attempts are being made to develop strains of cotton that will mature early enough to escape damage by frost which would thereby reduce the amount of bollie cotton. Other desirable fea-

tures being sought are semi-cluster fruiting habit, storm-proof bolls, high yield, a percentage of lint of 37 or above, and a good quality of one-inch staple. In 1936, inbred strains of Kubela and cut leaf, or okra leaf, Acala, grown under irrigation yielded more than a bale to the acre and gave good results in harvesting trials with the Texas Station harvester.

The results of other phases of the project, including the efficiency of cotton harvesting machinery, the development of cleaning machinery, and the ginning of mechanically harvested cotton, are given in the report of the Division of Agricultural Engineering.

D. T. Killough, H. P. Smith, D. L. Jones.

Variety Test of Legumes

The variety test of legumes is conducted at most of the substations to determine the varieties best adapted for forage production and for soil improvement in different parts of the state. Both winter-growing and summer-growing types of legumes are included in the test. The work was carried in 1936 but was not satisfactory at several substations on account of drought. For example, the test with soybeans was a complete failure at College Station, and very low yields were obtained at Denton. The whole test was a practical failure at Chillicothe.

Winter-growing Legumes. In general the results obtained with winter legumes at Tyler, Nacogdoches, Angleton, College Station, and Denton indicate that hairy vetch is perhaps the most suitable winter-growing legume for soil-improvement purposes in those parts of the state. At these points hairy vetch has produced the largest average yield of air-dry forage. It also contained considerably more nitrogen than the other winter legumes and consequently when plowed under would add more nitrogen and organic matter to the soil.

Subterranean clover was by far the best winter legume at Beaumont, producing an average yield of 2.52 tons of air-dry forage per acre during the last two years. Although this clover has made the largest yield of air-dry forage, it produces its seed at the surface or beneath the surface of the soil which renders it difficult to harvest the seed. Its high yield of forage and character of growth, however, should make it a good winter grazing crop for the region.

Hubam clover has been one of the best winter-growing clovers at College Station, Temple, Beeville, and Winter Haven. It has good seedling habits which are favorable for seed production.

Summer-growing Legumes. Cowpeas and velvet beans have produced more nitrogen in air-dry forage at Tyler and Nacogdoches than other summer-legumes, although they have not necessarily made the largest yield of forage. For instance, during the three years 1933-1935 at

Tyler, bunch velvet beans produced the largest yield of forage, 3.03 tons per acre, which contained 159 pounds of nitrogen. Cowpeas produced an average yield of 2.47 tons per acre containing 147 pounds of nitrogen. Soybeans also have produced good yields of forage, 2.56 tons per acre, with 121 pounds of nitrogen.

At Angleton and Beaumont soybeans have produced about as large yields as other summer legumes tried and considerably more nitrogen. Thus, at the Angleton Station, Ootootan soybeans made an average yield of 2.34 tons of air-dry hay per acre, while sesbania made the largest yield, 2.42 tons. The soybeans forage, however, contained 111 pounds of nitrogen per acre and sesbania forage only 59 pounds. At Beaumont, Ootootan soybeans produced an average yield of 3.24 tons of forage.

Biennial white sweet clover has been the best clover at Denton.

Crotalaria, sesbania, and Brabham cowpeas have made the largest tonnage of forage at Weslaco. During the last two years crotalaria produced an average yield of 6.95 tons of air-dry forage; sesbania, 3.97 tons; and Brabham cowpeas, 3.63 tons.

None of the summer legumes has been entirely successful at Temple, Lubbock, Spur, and Chillicothe.

E. B. Reynolds.

Germination and Longevity of Bitterweed Seed

Work on the project was begun at the Ranch Experiment Station, Sonora, in November, 1931, to get some definite information on the viability and longevity of the seed of bitterweed, *Actinca odorata*. Tests have been made on the germination of the seed at monthly intervals since 1931. Seed that matured in the spring of 1931 had a germination of 72 per cent when the test began. The seed, however, gradually lost their viability. Seed stored in the laboratory lost their germinating power more slowly than seed stored in an enclosure exposed to the weather. The germination tests were discontinued in November, 1936, because the seed heads stored outside had disintegrated so completely that satisfactory samples could not be obtained for germination tests. At this time, January, 1937, both lots of seed contained viable seeds but the percentage of germination is only a fraction of 1 per cent.

E. B. Reynolds, V. L. Cory, W. H. Dameron.

Factors Affecting the Presence or Absence of Cotton Root-Rot Disease in Alluvial Soils

This project is a part of the general investigations on the root-rot disease of cotton. The work is being conducted at Substation No. 5, Temple, and vicinity, and the results are given in the report of that substation.

H. E. Rea.

Inheritance and Improvement in Sorghum

Milo blight, or milo rot, caused by a soil borne fungus (*Pythium arrhenomanes*), has caused extensive losses to the milo crop in Texas during the past two years. A recent survey indicates that the disease is rather widespread over the milo-growing region. It made its appearance on the Station farms at Spur and Lubbock this year for the first time and appears to be spreading rapidly, particularly in the Red Beds and Low Plains region. The usual symptoms of this disease are wilting, discoloration of the lower leaves, and either dying or stunting of the plants, so that it is commonly confused with drought damage or chinch bug infestation. It is only in cases of severe infection, when practically an entire crop of milo will die in a few weeks, that the disease is readily identified as such by farmers.

It appeared that the abandonment of Dwarf Yellow milo and the planting of kafir, feterita, and Hegari was the only solution of the problem, but fortunately resistance to this fungus was found in pure Dwarf Yellow milo and resistant strains of this crop should soon be available for general distribution. In 1935 some 800 milo plants that survived serious infection of the disease on a farm in Runnels county were selected, and later tests on infested soil in the greenhouse, as well as plantings back on the same infested soil in the field, proved a large number of them to be resistant. This point established, it remained only to identify the most desirable strain among original selections and to increase pure seed of it for distribution to farmers. It is important that the strain selected for distribution be equal or superior to ordinary Dwarf Yellow milo when the disease is not a factor. In view of this fact no effort was made in 1936 to increase a large supply of seed of any of the resistant strains found. A dry summer interfered considerably with field plantings, but out of 200 strains tested on infested soil on the farm in Runnels county only five proved to be susceptible. Ordinary Dwarf milo and also these few susceptible selections produced only about 40 per cent as much grain as the resistant strains with which they were compared. Resistant selections were planted at Lubbock, Chillicothe, and Spur where further preliminary selections were made of the best-appearing strains. These will be placed in comparative field trials next year. In the meantime, one of the best strains in 1936 is being increased for a foundation supply of disease resistant milo stock to be grown by the certified sorghum seed growers for general distribution. Within a few years it is expected to entirely replace the old milo seed stock in the State with these new disease resistant strains.

Quadroon is the name assigned to a new variety of grain sorghum developed at the Chillicothe Station and given a preliminary distribution in 1935 and a wider distribution in 1936. As the name indicates, this new variety is of hybrid origin, its parentage being three-fourths milo and one-fourth kafir. Quadroon is about 10 days earlier than Dwarf

Yellow milo; it is straight headed and more resistant to chinch bugs than the milo parent. The seed is yellow and will undoubtedly be classed with milo on the market. This new variety will produce consistently even under adverse conditions, and it was on account of this consistency of production that it was distributed. Favorable reports of this variety have been received from all of the grain sorghum producing area of the State except the Gulf Coast region.

Sorghum breeding with the view to incorporation of certain desirable characters into important commercial varieties is under way. Numerous crosses and backcrosses have been made, both in the greenhouse and in the field, in order to bring together the desired characters. The work is greatly speeded up by growing material in the greenhouse during the winter and thus gaining an extra generation a year. Yellow seeded strains of feterita, kafir, and Hegari are in process of production by backcrossing to the desired parent after the factor for yellow seed has been introduced by hybridization with a yellow seeded variety. The work on a sorgo variety of Sumac type that has seed of low tannin content and is resistant to the common foliage diseases is progressing satisfactorily. Kafir and Leoti are the varieties other than Sumac that have contributed characters to this new sorgo variety. Breeding strains of Sudan grass for sweet and juicy stems, resistance to foliage diseases, and marked with distinctive glume colors, are in the process of development. Juicy and pithy strains of Sudan grass, having easily recognized seed with distinctive sienna and mahogany colored glumes, have now reached the stage where they are seven-eighths Sudan and one-eighth sorgo. Another backcross to Sudan will be made to approach more closely the Sudan grass type and yet retain these desired new characters. In addition to having seed in which a mechanical mixture with Johnson grass or other sorghums can be detected by inspection, these new strains should be more free from seed shattering than ordinary Sudan grass.

As reported in the last Annual Report, the X-radiation of Texas Blackhul kafir resulted in the production of approximately 60 seedling chlorophyll-deficient characters. The production of a number of mature characters at the same time was suspected but their presence was not confirmed until this year. Mature characters tentatively named Dwarf, Rusty-red foliage, Fired-leaf, Pale green, Yellow leaf-tip, Splotched-leaf, Red-leaf, and Japonica appeared in the X_3 generation. Inheritance studies of these characters was not completed this year as a very poor season caused classification of plants to be uncertain. The new characters appeared to be simple recessives but their inheritance will be studied further next season.

Studies to determine the magnitude of hybrid vigor that could be obtained from crossing certain varieties of sorghum with one another have been conducted to determine the most favorable combinations which might be used in connection with the production of crossed sorghum seed in quantities for commercial plantings. These studies of heterosis in

sorghum show that sorghum varieties differ in their genetic make-up for many genes other than those that are visible in their effect. Milo and Hegari were the two varieties whose hybrids invariably possessed extreme vigor, and it is apparent that these two varieties possess a good many dominant genes favorable to growth and production whose recessive allelomorphs are present in such other varieties as kafir, feterita, kaoliang, Sumac, and broomcorn. It is undoubtedly true that the pre-eminence of milo and Hegari, two of the most important grain sorghum varieties in Texas, and the two varieties grown in Southern California and Arizona under irrigation practically to the exclusion of other varieties, is due to the presence in their genetic make-up of a large number of dominant genes favorable to growth.

Hybrid vigor possessed by hybrids between such other varieties as kafir, feterita, kaoliang, Sumac, and broomcorn, although not as great as that of hybrids having milo or Hegari in their parentage, is great enough in many instances to result in grain production double that of their parents. Earliness of maturity is a characteristic of hybrids of this group.

Quite a large increase in production of grain resulted from crossing Blackhul with Red kafir and was accompanied by neither lateness of maturity nor an increase in height. These two varieties possess the same recessive genes for height but a number of different dominant genes that affect growth. It appears, therefore, that genes that directly influence height of plant are not the only genes that produce the marked vigor possessed by first-generation sorghum hybrids.

In the cases of least hybrid vigor, where hybrids were the offspring of two inbred lines of Blackhul kafir, the increased production resulted largely from a slightly greater tendency for the hybrids to tiller, without any increase in other vegetative characteristics.

These results indicate possibilities for the use of crossed sorghum seed and the practical utilization of hybrid vigor for increasing production, provided a practical method for producing crossed seed in quantity can be worked out. Such possibilities include the method of bulk emasculation of sorghum flowers with hot water, the use of a floral abnormality called "antherless" in which anthers are not produced within the sorghum flower, or through the utilization of stock segregating for male sterility, such as those which occur so commonly in corn and sugar cane. By planting alternate rows to a desirable pollen parent and weeding out all except the recessive male sterile plants in mother rows, all of the seed set on these recessive plants would be crossed seed producing F_1 plants. The male sterile stock could be propagated by cuttings and such mother rows might be perpetuated by establishing semi-permanent ratooning rows in the more southern regions of Texas where sorghums will over-winter rather than depending upon repeatedly isolating the male sterile recessives from seed in segregating stock.

A male sterile character, in which the anthers produce no pollen but with flowers that otherwise bloom normally, has recently been found in Texas Blackhul kafir by J. C. Stephens at the Chillicothe Station. The character behaves as a simple recessive and affords a long-awaited opportunity to test out the feasibility of using such a character in the production of crossed seed of sorghum for general planting. When the recessive male sterile is crossed back to plants heterozygous for this character, 50 per cent of the crossed seed should produce plants devoid of pollen. The other one-half of the plants will have to be weeded out before flowering, allowing the recessives to pollinate from adjoining pollen parent rows of a variety which is found to impart the desired degree of hybrid vigor to the first generation hybrids. Further experiments to test out the possibilities of producing crossed seed by such means are being conducted. Similar characters causing partial male sterility have also been found in Sudan grass and in selections of a milo-kafir hybrid.

R. E. Karper, J. R. Quinby, and D. L. Jones.

The Anatomy and Microchemistry of the Cotton Seed

(In cooperation with the School of Arts and Sciences,
A. & M. College of Texas)

Comparative anatomical studies of the seeds of various species of cottons, the results of which have been reported previously, indicated that except for quantitative differences the species are fairly uniform. These quantitative differences consist chiefly of variations in the relative thickness of volume of certain tissues. Work was undertaken recently to show whether this finding is applicable to the roots, stems, and leaves. The results obtained indicate that there is variation in the roots, stems, and leaves of the various species, but as in the seeds, the differences are mainly quantitative. Also there are such differences among the plants within a species. As a consequence, the variations are not sufficiently definite to enable one to make comparisons, unless an exhaustive study of this question were undertaken. The stems of the cottons have more prominent growth rings than are usually found in annual stems.

Previous results had shown that the rolling of cottonseed meats during the milling process broke the walls of 80.4 per cent of the cells, and that cooking increased this to 88.8 per cent. Further studies were made in an attempt to check these results. Cottonseed meats were cooked in a regular oil-mill cooker without being rolled, and were examined microscopically. It was found that none of the cells was ruptured, except when an occasional meat was broken by the agitation that occurred in the cooker. These results coincide with the previous finding that rolling is the principal cause of breakage of cells during the milling process.

R. G. Reeves.

Breeding Wheat and Oats for Resistance to Rust
(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

This is a new project in which the Texas Experiment Station and the Division of Cereal Crops and Diseases, U. S. Department of Agriculture, are cooperating. It has two main objectives. The first is to develop rust-resistant varieties of wheat and oats for South Texas where these crops cannot now be extensively grown. The second is to utilize the natural and severe rust epidemics which occur at College Station in isolating rust-resistant strains for North Texas, Oklahoma, and Kansas. It is believed that the general planting of a barrier of resistant varieties in these regions will prevent the northward spread of rust to the spring wheat belt.

All of the varieties and strains now known which possess factors for rust resistance have been assembled, and many hybrids have already been made in an effort to combine the various types of resistance. This, of course, will require a long-time breeding program.

In the meantime extensive tests have been made in South Texas to determine what parts of this region are suitable for small grain production and to isolate strains of wheat and oats adapted to the region.

Most of the strains of wheat tested in South Texas are selections from a hybrid of Hope, a rust-resistant spring wheat, and Mediterranean No. 63, a Texas strain resistant to leaf rust. The results in the 1935-1936 season were quite promising. The highest yields obtained at points where the crop was successfully matured were 13.8 bushels Beaumont; 26.5 bushels, Victoria; 19.0 bushels, Wharton; 19.2 bushels, Edna; 19.0 bushels, Bay City; 15.7 bushels, Orange Grove; 3.2 bushels, West Sinton; 20.8 bushels, Angleton; 8.8 bushels Beeville; and 31.0 bushels, College Station. It should be noted that these yields were all made in a region where wheat is not now grown. The results indicate that the region east of Houston is probably too wet for wheat production and that the region from Houston to Beeville has possibilities if adapted strains are isolated.

New oat strains isolated from hybrids in which one parent was resistant to crown rust have also been tested. The highest yielding oat at Beaumont produced 25.8 bushels, at Angleton 51.6 bushels, at Beeville 25.0 bushels, and at College Station 69.2 bushels. It appears now that oat varieties suitable for South Texas need resistance to stem rust as well as to crown rust, and new hybrids designed to introduce resistance to stem rust are now being made.

A very important observation made during the past season indicates that the black pigmentation of the stems characteristic of Hope wheat and rust resistant segregates from Hope hybrids is a manifestation of rust resistance, and not, as generally supposed, a bacterial disease "black

chaff." Breeders have been attempting for years to break the supposed genetic linkage between resistance to rust and susceptibility to black chaff. It is now evident that this black pigmentation develops only in resistant strains which have been infected with rust, and then only in the presence of light. It does not develop in susceptible strains, nor does it develop in resistant strains in the absence of light or when rust infection does not occur. The immediate practical importance of these observations lies in the fact that the pigmentation which has formerly been selected against may now be used as a sure mark of resistance to stem rust.

P. C. Mangelsdorf, E. S. McFadden, Bur. Pl. Ind.

Effect of Fertilizers on Yield, Chemical Composition, and Botanical Composition of Pasture Herbage.

(In cooperation with the Tennessee Valley Authority)

The principal object of this study is to determine the effect of fertilizers, especially phosphatic fertilizers, on the yield and chemical composition of pasture herbage. The experiment was conducted at College Station, Angleton, and Lufkin. At this time, however, the detailed results at Angleton and Lufkin are not available for this report. The work at College Station is conducted on the Feeding and Breeding Station and on the College Dairy Farm. The fertilizers were applied to rather uniform areas of pasture consisting mostly of Bermuda grass. The following fertilizer treatments, expressed in pounds per acre of nitrogen, phosphoric acid, and potash, respectively, were used: 0-40-0, 0-80-0, 20-40-0, 40-40-0, 40-80-0, and 40-80-40, 10 tons of manure, 10 tons of manure and 40 pounds of phosphoric acid, and no treatment. All of the phosphoric acid was applied in the form of triple superphosphate furnished by the Tennessee Valley Authority.

The fertilizer treatments that included nitrogen, especially larger amounts, produced significantly larger yields than the treatments which contained no nitrogen. Thus on the Feeding and Breeding Station, the 40-80-40 treatment produced 1888 pounds of air-dry forage at three cuttings, which was 863 pounds more than the yield of the 0-40-0 treatment, 842 pounds greater than the yield of the 0-80-0 treatment, and 793 pounds more than the yield of the unfertilized grass. All of these differences are strongly significant and indicate that fertilizers had a favorable influence on yield.

Somewhat similar results were obtained on the College Dairy Farm. The 40-80-0 treatment made the largest yield at two cuttings, 3051 pounds of air-dry forage per acre, which was 1058 pounds more than the yield of the plats that received no fertilizer. The 40-80-0 treatment produced significantly larger yields than the treatments 0-80-0, 0-40-0, and the unfertilized plats.

Samples of herbage were taken for chemical analysis. The analysis, however, has not been completed and the results are not yet available.

These results indicate that the 40-80-0 and 40-80-40 treatments produced enough increase in yield of forage to pay for the fertilizers and return a small profit under rather unfavorable weather conditions during the season.

E. B. Reynolds, R. L. Hensel, G. S. Fraps, J. H. Jones.

Improvement of Range and Pasture Plants

The purpose of this work is three-fold: first, to ascertain the grasses best adapted to the three major areas which are centered around Lufkin, in East Texas; Angleton, in the Gulf Coast Prairie; and Sonora, in western Texas; second, to develop more productive and nutritious strains; and third, to determine the best methods to use in their establishment. The selection and breeding work will be done largely at College Station.

Work on this project was started during the year and is concerned largely with buffalo grass, which seems to be adapted to a larger portion of the State than other grasses. Seed burs, or pistillate spikes, from Chillicothe and Temple were studied to ascertain the number of seeds per bur. Normally 2 to 5 spikelets occur in each bur so that it would be possible to produce a like number of seeds providing each spikelet was fertilized. The examination disclosed that an average of 1.1 seeds was produced per bur. The largest number found was 4, which was very infrequent. The reason for this small percentage of fertilization is not known but will be studied at a later date.

Seed burs from both Temple and Chillicothe were placed in a germinator at a temperature of 30° C for several weeks. In approximately four days the most vigorous seeds began to sprout and at the end of seven days practically all of the viable seeds had germinated. The results showed that seed burs from Temple had a germination of 34 per cent and those from Chillicothe, 36 per cent. However the seedlings from the seed obtained at Temple were noticeably more vigorous. Since the seed burs are tough and quite impervious to moisture, it was decided to break the coat in such a manner that the bare seed would be exposed. This was accomplished by running them through an ordinary coffee bean grinder. In a germination test, 71 per cent of these seeds germinated within seven days, indicating that removing the burs doubled the germination. From these results it may be reasonable to infer that removing the hull, or coating, from the seed may be desirable practice in field planting.

Dehulled seed from Temple, Chillicothe, and Encinal have been planted in the greenhouse. Individual plants will be transplanted to pots and when large enough they will be cut into four pieces and one portion planted in each of four plats to study the botanical differences in an

effort to find desirable strains for further study. Seed of other promising native grasses have been gathered and will be studied in 1937.

A two-acre experimental grass nursery is being established in which this work will be conducted. Water for irrigation will be available when needed. Promising grasses will be tested in this nursery and sent to other stations when conditions warrant. It is contemplated that the nursery will be in full operation by the summer of 1937.

R. L. Hensel.

Limiting Factors in Pasture Production

Many factors influence pasture production. In general these factors apply to all pastures and ranges irrespective of geographical location; for example, overgrazing is a factor wherever pastures are grazed. In specific localities, however, certain factors are dominant. It is evident that in eastern, southern, and western Texas, certain factors are characteristic and outstanding, and these will be used as a basis for study designed to develop methods of controlling them in order to increase the productivity of pastures and ranges. From investigations already made it has been shown that soil fertility is perhaps the limiting factor in East Texas, and weeds and worthless grasses which have replaced and are replacing the more valuable grasses are the principal limiting factors in the Gulf Coast region. In western Texas water in the form of rainfall and the rapid spread of cactus, lechugilla, mesquite, and other kinds of brush are the limiting factors. Undoubtedly, there are other factors of lesser importance in each of these regions which will be studied at a later date.

The work with pasture fertilizer is now under way at Lufkin, Angleton, and College Station. At College Station the application of fertilizers containing nitrogen and phosphorus produce significantly higher yields than untreated areas. The excellent quality and high productivity of the improved pastures at the Lufkin Station are due in a large measure to the fertilizers which were applied to them.

Experiments to determine the effect of burning were started on the mesquite-tobosa grass pasture in King county. The area used was an 1800-acre pasture containing approximately 300 small mesquite trees to the acre. The pasture contained a large amount of tobosa grass growing between and under the mesquite trees. Five plats, each containing one acre, were protected from fire by plowing furrows around them. These served as check plats which are compared with areas burned at different dates. The entire pasture was burned on August 14, 1936. The fire spread rapidly and it was estimated that the maximum heat at any one spot lasted only about 20 seconds so that no damage was done to the underground parts of the perennial grasses. In early September favorable rains fell, and by the first week of October the grasses had grown vigorously and were the greenest on the ranch. Cattle were grazing

the tender tobosa grass shoots, thus making available forage which would not have been palatable unless the area had been burned. The burning killed the mesquite trees to the ground but new sprouts were coming up from the roots in early October. Efforts will be made to ascertain if burning can be done at a time when food reserves of the mesquite are low so that sprouting will be eliminated.

It is planned to continue work on all phases of this project on an intensive scale.

R. L. Hensel.

Management of Grazing Lands

This project is designed to develop methods of grazing range lands and pastures that will tend to yield the maximum production and yet maintain a degree of stability from year to year. The field work is to be done at Lufkin, Angleton, and Sonora, supplemented by certain basic work that can be done at College Station. The procedure will be to make a study of the several factors which have a direct or indirect bearing upon the life and growth of the principal range vegetation, its adaptation to the kinds of livestock grazed upon it, and the period of productivity of the different species for the purpose of estimating the significance of critical periods throughout the season and from season to season, with the view to developing proper methods of grazing to safeguard against these periods which tend toward instability in range feed values. This may involve supplementary crops of hay or silage, or supplementary feeds, but it is essentially concerned with the maintenance of feed values at a high level at those periods which determine in a large measure the soundness of the grazing practices followed.

It is recognized that each of the principal regions in the State has its own problems which must be analyzed. From these results a well-rounded, efficient, economical, and practical plan will be formulated. This will require several years and must be done in connection with other pasture projects.

R. L. Hensel.

MAIN STATION AGRONOMY FARM

The Main Station Agronomy Farm is located on the land of the Agricultural and Mechanical College of Texas at College Station, Brazos County, and comprises 101 acres of land, of which 76 acres is used for experimental purposes and the remaining acreage for buildings, pastures, and roadways, and for production of seed of superior strains of crops developed on the farm.

Rotation, Fertilizer, and Soil Improvement

During the 22-year period (1914-1936) the treatment of superphosphate and manure gave an average yield of 234 pounds of lint cotton to the acre, and the treatment of manure alone gave an average yield of

227 pounds of lint cotton. On the other hand, the plat receiving no treatment and from which the crop residue had been removed each year was 166 pounds of lint cotton, and the average of the check plats which also received no treatment but had the crop residue plowed under was 161 pounds lint cotton in the rotated cotton, against 204 pounds of lint cotton for the manure and superphosphate treatment and 228 pounds of lint cotton to the acre for the manure alone, and 175 pounds of lint cotton from the plat which had the crop residue plowed under, 184 pounds of lint cotton for the average yield of the check plats in the continuously-planted cotton.

For the same period, the treatment of manure alone gave an average yield of 24.7 bushels of corn to the acre, while the manure and superphosphate gave 23.5 bushels, the plat from which the crop residue had been removed, 19 bushels, and the average of the check plats 19.5 bushels of corn to the acre for the rotated corn; against 17.7 bushels for manure and superphosphate, 16.6 for manure alone, 12.4 bushels for the plat from which the crop residue had been removed, and 12.3 bushels for the check plats in the continuously-planted corn.

For the 22-year period, cottonseed meal and superphosphate produced the highest yield of oats, 16.5 bushels to the acre, while the plat which received no treatment and from which the crop residue had been removed, produced 14.8 bushels to the acre. The average yield of the check plats which received no treatment but had the crop residue plowed under was 13.6 bushels to the acre.

Soil Fertility Studies

These studies were based on a three-year rotation of oats, cotton, and corn in which a 4-12-4 commercial fertilizer at the rate of 400 pounds to the acre was used as a standard treatment, and each element—nitrogen, phosphoric acid, and potash—was varied in turn while the other two were kept constant.

The 4-12-4 fertilizer was also used at rates of 200, 400, 600, and 800 pounds to the acre.

In 1936 the average yield of all plats receiving a treatment of 400 pounds of a 4-12-4 fertilizer was 191 pounds of lint cotton to the acre. The plat receiving a treatment of 12 tons of manure produced 321 pounds of lint cotton, while the plat receiving no fertilizer treatment produced 106 pounds.

From 1927 to 1936 the treatment of 12 tons of manure and 400 pounds of superphosphate to the acre produced the highest average yield of lint cotton, 365 pounds to the acre, while the average yield of the plats receiving a treatment of 4-12-4 fertilizer at the rate of 400 pounds to the acre was 298 pounds of lint, and that of the plat receiving no treatment was 215 pounds.

In 1936 the plat receiving the treatment of 12 tons of manure and 400 pounds of superphosphate to the acre produced the highest yield of corn, 38.2 bushels to the acre, while the treatment of 800 pounds of a 4-12-4 commercial fertilizer produced 38.0 bushels, and the plat receiving no treatment produced 28.1 bushels of corn to the acre.

From 1927 to 1936 the plat receiving the treatment of 12 tons of manure and 400 pounds of superphosphate produced 31.1 bushels of corn to the acre, while the plat receiving no treatment produced 21.8 bushels.

In 1936 the plat receiving the treatment of 400 pounds to the acre of a 4-12-4 commercial fertilizer produced the highest yield of oats, 32.9 bushels to the acre, while the plat receiving no treatment produced 17.1 bushels to the acre.

From 1927 to 1936 the plat receiving the treatment of 400 pounds of a 4-12-4 commercial fertilizer produced the highest average yield, 21.1 bushels of oats to the acre, while the plat receiving no treatment produced 16.2 bushels of oats to the acre.

Cotton Variety Test

Of the 32 varieties tested in 1936 the four varieties producing the highest yield of lint were Sunshine with 168 pounds, Roldo Rowden with 159 pounds, Ferguson No. 406 with 161 pounds, and Startex 619 with 156 pounds of lint to the acre.

For the ten-year period from 1927 to 1936, New Boykin made the highest average yield, 244 pounds of lint to the acre, Sunshine 223 pounds, Cliett 210 pounds, and Harper 203 pounds. For the six years that Startex cotton has been included in this test, it has produced an average yield of 241 pounds to the acre, and when the yield of this variety is compared with that of the varieties that have been planted for ten years there is a yield of 236 pounds of lint cotton to the acre against an average yield of seven standard varieties of 208.4 pounds of lint to the acre.

Cotton, Soil Fertility and Spacing Test

This was planted with the object of determining the best distance to leave between plants or thickness of stand on poor, medium, and fertile soil. The spacings were used 12 inch, 18 inch, and 24 inches.

Six replications were planted on each type of soil. This year's results indicate that on a poor soil, slightly higher yields of cotton can be obtained from the 12 and 18 inch spacing than from the 24 inches between plants. On the medium soil the 18-inch spacing gave higher yields than either the 12-inch or the 24-inch spacing. On the fertile

soil the close spacing of 12 inches between plants gave much higher yields of cotton than the 18-inch or 24-inch spacing.

Cotton, Regional Variety Test

Sixteen standard varieties of cotton were planted in eight replications. Dixie Triumph was the high yielder in the test in 1936.

Peanut Variety Test

Ten varieties of peanuts were planted in 1936, and of these Java Toeban produced the highest yield of nuts, 46.5 bushels to the acre. Nagspur produced 41.6 bushels and Improved Spanish 36.7 bushels to the acre.

For the five year period from 1932 to 1936, Improved Spanish has produced the highest average yield, 41.7 bushels to the acre, Java Toeban 39.1 bushels, and San Jose 34.4 bushels to the acre.

Increase plantings were made in 1936 of the Macspan, Pearl, and the Macspan x Virginia Bunch hybrid.

Winter Legume Test

Of the 25 legumes planted in 1936, Purple Vetch produced the highest yield of forage, 2.89 tons to the acre. This was the average of four plantings. This year one of the four plantings had the seed treated with nitrogen, and a marked increase was noted in the yields of the treated over the untreated seed.

Hairy vetch, which had been the high-producing legume in previous years, produced this year 2.41 tons of forage. Oregon vetch produced 2.17 tons to the acre, Austrian pea .91 of a ton, and Canada pea .89 of a ton, while Italian Rye grass made 1.28 tons to the acre.

Alsike, subterranean, White Dutch, and Red Clover all made good growth especially on the plats that had the seed treated with nitrogen.

Increase of Pure Seed

Increased plantings were made of Startex cotton, Yellow Surcrotter corn, Macspan and White Pearl peanuts, in order to make distribution of these crops to farmers, and to increase production of pure seed for further distribution through the State.

Soy Bean Variety Test

Sixteen varieties of soy beans were planted at three planting dates, for the purpose of seed production. Although most of the varieties in

this test made vegetative growth, there was no variety in the test that produced sound pods. It appears from this and previous tests made with soy beans that they are not adapted for seed production at College Station.

Strip Cropping

In order to prevent soil damage from sheet erosion, strip cropping has been used for the past two years. Upon each acre used in clean culture crops, two strips 15 feet wide have been planted in small grain in the fall of the year, before the crop residue of the crops in the test has been plowed under. The grain is cut the following spring with a high stubble after the row crop on the balance of the acre is up; then the strips are allowed to grow in native vegetation. This system has proved adequate for the control of sheet erosion.

G. T. McNess.

PLANT PATHOLOGY AND PHYSIOLOGY

Cotton root-rot disease

Considerable time was devoted during 1936 to research on the cotton root-rot disease. The methods of procedure and the lines of work pursued were the same as mentioned in the last annual report. Studies were continued on the life history of *Phymatotrichum omnivorum*, including study of the spore stage; on spread and persistence in the vegetative stage and in the sclerotial or resting stage; on the environmental factors which affect the root-rot fungus; and on methods of control.

The vegetative stage of *Phymatotrichum omnivorum* occurring on roots at various depths

On a farm in Brazos county, 2 sprouting American elm stumps were excavated in a field where cotton was dying. With one stump, 1½ feet of the upper portion of the old root were completely decayed, but all the new sprouts had originated from a depth of 2 to 2½ feet around the lower portion of the living part of the tap-root. The base of two of the sprouts showed typical root-rot lesions with viable *Phymatotrichum* strands as proved by soil cultures. From the 2 sprouts, strands of *P. omnivorum* were traced down 4 feet along the tap-root, and a number of old as well as new root-rot lesions were found. The other sprouting stump excavated also showed new as well as old root-rot lesions on one side of the living tap-root, below the rotted area which extended from the surface to 1 foot deep. *Phymatotrichum* strands were traced down to a depth of 7 feet along the tap-root of this stump. Numerous live cotton roots in various degrees of root-rot infection were found entwined around the tap-root of this stump. This substantiates previous work indicating that root rot survives on living portions of tap-roots of sprouting stumps.

J. J. Taubenhaus.

Persistence of the root-rot fungus in its resting or sclerotial stage

Laboratory studies on longevity of sclerotia: In October, 1929, sclerotia were recovered from an infested carrot field at Temple, Texas, placed in small corked vials in moist Houston clay soil, and kept thereafter at room temperature in the laboratory. Each year some of the sclerotia were removed from 2 vials and placed on moist filter paper in Petri dishes to test their viability. Originally, during 1929, 82 per cent of the sclerotia were viable. In successive years the percentages of germination were 46, 28, 21, 11, 12, 10, and now after 7 years, 8 per cent.

J. J. Taubenhaus.

Viability of sclerotia: This report is included under Substation No. 5.

Depth of sclerotium formation in the field: Sclerotia of *P. omnivorum* were found beneath one of the two cut-over sprouting elm trees excavated, at a depth of 5½ feet, in close proximity to the deep-seated root-rot lesions on the tap-root. The sclerotia occurred in pockets, and over 90 per cent were borne in clumps. Seventy-three of these sclerotia were placed on moist filter paper and 49, or 67 per cent, germinated readily. The remainder, non-germinating sclerotia, were found infested by a species of nematode.

J. J. Taubenhaus.

Variation and dissociation within the root-rot fungus

Dissociation of the fungus when carried in artificial culture has been reported in previous reports. An experiment was started in 1935 to explore the possibility that similar variation in the fungus on the roots of diseased plants may be associated with periodic changes in prevalence of root rot that cannot be ascribed to weather or other environmental changes. Root rot was introduced in 1935 by pure-culture inoculation of cotton plants growing in a root-rot-proof, sulphur-slab container. Cultures were re-isolated at intervals during 1936 from diseased plants. Early comparison of re-isolated cultures with the original culture showed certain slight changes in the fungus, as compared with descriptions of the original inoculum or with current cultures carried along from the inoculum, indicating that some variation has already occurred. The relative extent of such variation and its possible association with the wax and wane of epiphytotics remains to be determined in later years.

W. N. Ezekiel.

The Phymatotrichum spore stage

During 1936, typical spore-mats were found in the field in Brazos county only above roots of recently infected plants, rather than of

plants that had succumbed to the disease some time before. The spheroidal to ellipsoidal or ovoidal spores averaged about 4.5 to 5.0x3.7 to 4.0 microns in size. The spores measured ranged from 3.5 to 5.8x2.9 to 4.5 microns.

Experimental attempts to produce spore-mats in the laboratory have not yet been successful. Mats did develop, however, in an experimental container outside, in which cotton plants were succumbing to root rot induced by artificial inoculation with a pure culture of the fungus (strain 41); this indicates that the production of spore-mats is probably not limited by need of interaction of various strains.

Germination of spores was attempted in drop cultures on substrata that included synthetic media and potato-dextrose agar, used separately and plus portions of living cotton rootlets added aseptically. Spores were taken from immature mats, from those just matured, and from old mats, and were collected respectively dry and in sterile distilled water. Some experiments compared spores used as collected with spores previously treated for various periods in diluted soap solutions or with a dilute commercial spreader (Aresket) solution. Despite long-continued observation of literally millions of spores, no definite germination was observed.

Atypical spore mats commonly found in oak woods (designated recently as *P. silvicolum* Taubenhaus and Watkins) were studied in comparison with the typical *P. omnivorum*. The usually small mats in the woods were apparently not associated with roots of diseased plants; spores from these mats differed from those of *P. omnivorum* by being slightly more spheroidal, and ranged in measurements from 3.8 to 5.7 by 3.2 to 5.2 microns. Spores from these mats failed to germinate in the few experiments in which they were included.

W. N. Ezekiel.

Some Basidiomycetes found associated with plants killed by root rot: In search of a possible perfect stage of the root-rot fungus, a white supine form identified as *Poria ambigua* Bres. and a sulphur-yellow mushroom, possibly *Lepiota cepaestipes* Fr., have been found frequently associated with plants attacked by the disease. An unidentified fungus which, however, has been shown to be a lamellate or poroid Basidiomycete, has been obtained in transfer of a strain of *P. omnivorum* previously carried in artificial culture for more than 6 years. In hanging drop cultures, hyphae of this Basidiomycete anastomose profusely with hyphae of known *P. omnivorum*, but tend to deteriorate rapidly following such fusion. The possible relationship of the various Basidiomycetes mentioned to the root-rot fungus is to be studied further.

W. N. Ezekiel.

A new Phymatotrichum

During the fall of 1936, material of an undescribed species of *Phymatotrichum* was collected from wooded areas in Brazos county. This fungus

has been under observation for a number of years, growing on the surface in moist sandy soils in post oak woods in Brazos, Robertson, Grimes, and Smith counties. A study of this organism showed it to be distinct from *P. omnivorum*, and the name *Phymatotrichum silvicolum* Taubenhaus and Watkins has been given to this organism.

Mats of *P. silvicolum* appear as irregular small, turf-like patches of upright fungous hyphae and spores, white when young but becoming light brown or gray and powdery at maturity. In size the spore-mats range from 1 to 4 centimeters. Under the microscope the upright hyphae are simple or compound (synematus) colorless filaments with frequent lateral branches. These branches are the conidiophores upon which are produced the colorless, spherical conidia which range in diameter from 2.0 to 4.6 microns. The conidiophores are apically branched in a finger-like fashion, and bear the conidia thickly inserted from the tips to a point below the origin of the branches. The conidia originate as minute papillae on the surface of the conidiophores, and later develop into spherical spores borne on short stalks. A full description of this organism will appear in a forthcoming paper.

J. J. Taubenhaus, G. M. Watkins.

Effects of various environmental factors on the root-rot fungus

Some further nutritional studies: In Petri-dish cultures on a rich synthetic medium, a poor synthetic medium, and potato-dextrose agar, each used respectively with and without addition of 1 per cent carrot juice, the rate of extension of colonies of *Phymatotrichum omnivorum* did not correlate with final profusion of growth. Most rapid growth occurred with the poorest medium, with ammonium nitrate as the source of nitrogen and a low dextrose content, yet only sparse final growth resulted. Addition of carrot juice apparently accelerated growth on all the media. This would suggest that at least a portion of the accessory growth-promoting effect of carrot juice added to media, as reported in our previous work, may be due to materials not present in peptone or potato decoction, which were ingredients in some of the media.

W. N. Ezekiel.

Continued study on the nature of immunity of monocotyledonous plants to *Phymatotrichum* root rot: Work reported in previous years has indicated that the general immunity of monocotyledonous plants to root rot is due at least in part to the presence in roots of these plants of ether-soluble materials, which however are soluble in sodium-carbonate solution. Another monocotyledonous plant, Johnson grass (*Sorghum halepense*), has been studied with similar results. Ether extract from juice from the roots

was potent in preventing growth of *P. omnivorum*; washing the ether extract with aqueous sodium-carbonate solution removed the potency, while ether extract from the acidified sodium-carbonate solution washings was again potent.

Another experiment proved that the potency of fractions of onion juice in preventing growth of a new strain (43) of *P. omnivorum*, using inoculum from agar slants, was approximately the same as that found previously with strain 24 and inoculum from sclerotial masses. This indicates that the reaction involved was probably not specific for either strain but instead general for *P. omnivorum*.

With both onion and canna-root material, the final sodium-carbonate soluble fractions, stored in ether in the refrigerator, showed definite increases in potency after 8 months and 8 days, respectively, despite losses in dry weight of soluble material. This suggests that the potent materials effective in preventing growth of *P. omnivorum* in the cultures may be oxidation products, and evidence of existence of some other material in the plant, rather than necessarily identical with the material as found in the roots.

W. N. Ezekiel, J. F. Fudge.

On the nature of immunity of dicotyledonous plants to *Phymatotrichum* root rot: Certain dicotyledonous plants are known to be immune or highly resistant to *Phymatotrichum* root rot. It was desired to determine whether the cause of this resistance is present throughout the entire root, or localized to certain parts. Fresh roots of pomegranate, mesquite, live oak, and Parkinsonia, all highly resistant hosts, were secured; each was separated into 3 portions: (a) entire root portions, (b) epidermis and cortex, and (c) central cylinder; then placed in small Erlenmeyer flasks, with distilled water, autoclaved, and inoculated with pure-culture sclerotia of *P. omnivorum*. Cotton roots, representing a highly susceptible host, were given the same treatment and inoculated as checks. With the pomegranate, mesquite, live oak, and Parkinsonia, the best growth of the fungus occurred on the central cylinder, a trace to no growth on the epidermis and cortex, and poor growth on entire root portions. With cotton roots, the best growth occurred on entire root sections and on portions of the central cylinder, but only medium growth on the epidermis and cortex. This would indicate that the factors of resistance in some of the highly resistant dicotyledonous plants seems to be localized in the epidermis and cortex. A certain amount of this resistant property appears to be localized in the epidermis and cortex even of a highly susceptible host such as cotton. By this laboratory method a short cut is now available by which the resistance or susceptibility of dicotyledonous plants may be quickly determined. Further work is now in progress to determine whether the factors involved in the resistance of certain dicotyledonous plants are the same as in monocotyledonous plants.

J. Taubenhaus, G. M. Watkins.

Growth of *Phymatotrichum omnivorum* on roots of cotton varieties planted under different soil and climatic conditions in Texas: Live roots were secured of the cotton varieties Half and Half, Mebane 804-50, and Lankart grown at Substations No. 2 at Tyler and at No. 5 at Temple, Texas. Portions of the roots from these two sources were cut up, placed in test tubes with distilled water, sterilized, and inoculated with *P. omnivorum*. The fungus grew equally well on roots from the sandy East Texas soils, unfavorable to root rot, and on roots from the Central Texas Black-land soils very favorable to the disease. The fungus also grew readily on roots of the varieties Delpress 3, Hi-bred, and Rhyne's Cook, obtained from Tyler, Texas. From this it appears that the East Texas soils do not make the cotton plant itself resistant to attacks of root rot, but that the East Texas soils are unfavorable probably on account of the direct effect of the soil acidity on the fungus.

J. J. Taubenhaus, G. M. Watkins.

Growth of *Phymatotrichum omnivorum* in soil cultures from root-rot spots: During 1935 Crockett clay loam soil was secured from the center of a large root-rot spot in a field in Brazos county where the disease had killed out most of the cotton plants. Soil was removed also from the outer zone of the same root-rot spot where the disease was still advancing and from a spot in the same field where the cotton appeared normal. These samples were allowed to dry. During 1936, similar samples were taken from the same field; and soil cultures were made of the dried soil secured during 1935, and the fresh soil of 1936. Good growth of *P. omnivorum* resulted in all the soil cultures, irrespective of the source of the soil or the previous drying.

J. J. Taubenhaus.

Growth of *Phymatotrichum omnivorum* in soils with high concentrations of commercial fertilizers: This is a continuation of previous work in which *P. omnivorum* was grown in Mason jars respectively filled with Houston clay and Lufkin fine sandy loam plus various rates of fertilizers. *P. omnivorum* grew well in Lufkin fine sandy loam treated with 15-40-13.5 fertilizer at 1,000, 4,000, 8,000, 12,000, 16,000, and 20,000 pounds per acre. Using the same fertilizer in Houston clay, *P. omnivorum* grew best at 1,000 and 4,000 pounds per acre; growth was reduced at 8,000 to 16,000 pounds per acre, and almost inhibited at 20,000 pounds per acre.

With ammonium nitrate alone (35 per cent nitrogen) growth was fairly uniform from 1,000 to 20,000 pounds per acre in the Houston clay soil; but in the Lufkin fine sandy loam soil, growth was best at 1,000 to 8,000 pounds per acre, decreased at 12,000 pounds per acre, and was definitely inhibited at 20,000 pounds per acre. Using muriate of potash alone (48 per cent potash), fairly uniform growth resulted

in the Houston clay soil from 1,000 to 20,000 pounds per acre; while in the Lufkin fine sandy loam best growth resulted at rates of from 1,000 to 8,000 pounds per acre, and growth was inhibited at 20,000 pounds per acre. Using superphosphate alone (20 per cent phosphoric acid) fairly uniform growth was secured in both soil types from 1,000 to 20,000 pounds per acre. With sodium chloride alone, fairly uniform growth occurred in the Houston clay soil from 1,000 to 16,000 pounds per acre but growth was greatly reduced with 20,000 pounds per acre. In the Lufkin fine sandy loam soil, on the other hand, best to good growth was secured at 1,000 to 8,000 pounds per acre, and growth was definitely inhibited at 16,000 to 20,000 pounds per acre. Using calcium chloride alone in the Houston clay soils best to good growth was secured at from 1,000 to 16,000 pounds per acre, and growth was somewhat reduced at 20,000 pounds per acre; while in the Lufkin fine sandy loam fairly uniform good growth was secured at from 1,000 to 8,000 pounds per acre, considerable growth reduction at 12,000 pounds per acre, and definite reduction at from 16,000 to 20,000 pounds per acre. These experiments indicated that, in general, *Phymatotrichum* is able to tolerate considerably higher amounts of fertilizer than the cotton plant itself and, furthermore, the effect on *P. omnivorum* of the higher applications of fertilizer varies with the type of soil used.

J. J. Taubenhaus, G. M. Watkins, P. Macy.

Growth of *Phymatotrichum omnivorum* in decoctions from lumber:
Previous work has clearly demonstrated that *P. omnivorum* dies out with the complete decay of the roots of its host. In these experiments, boards of red cedar, blue ash, Arkansas yellow pine, white pine, cottonwood, and short-leaf yellow pine were divided into 4 lots: one hung up in the laboratory under dry conditions; another hung up in an open shed; a third placed in the open on surface of the soil; and a fourth buried 6 inches deep in moist soil. At the end of the year the boards from the four lots were assembled; each lot carefully washed, dried, and ground; and 24 wood decoctions prepared from this pulp. Each decoction was then divided into 5 series of flasks: one of undiluted decoction, the second of undiluted decoction plus 40 grams of dextrose per liter, the third of undiluted decoction plus chemicals of Medium 70, the fourth of decoction diluted with 3 parts of water, the fifth of decoction $\frac{1}{4}$ strength plus chemicals of Medium 70. This gave 120 different set-ups which were replicated 11 times, making a total of 1440 flask cultures, each containing 50 cc of the simple or modified decoction. All were adjusted to pH 7.0, plugged, sterilized, and inoculated with pure-culture sclerotial masses of *P. omnivorum*. The fungus grew on all the undiluted decoctions from all of the different boards used. However, growth was exceedingly scanty on the undiluted decoctions from any of the variously treated boards, as compared with the growth obtained when the fungus was grown on Medium No. 70, or when nutrients were added to the undiluted decoctions of the boards. Chemical analyses of the undiluted

decoctions from these boards showed that they contained only traces of nutrients, which explains why they were poor substrata for growth of *P. omnivorum*. This agrees with field observation that *P. omnivorum* in nature is not found to grow on wood portions or boards or on dead roots of various kinds.

J. J. Taubenhaus, G. M. Watkins, G. E. Altstatt, P. Macy.

Effect of other organisms on the growth of *Phymatotrichum omnivorum*: In previous reports it was mentioned that a species of *Trichoderma*, *Sclerotium rolfii*, and *Diplodia gossypina* was strongly antibiotic to *P. omnivorum*. In work during 1936, studies were made on 3 species of *Trichoderma*: *T. lignorum*, *T. koningi*, and *T. globosum*, all isolated from roots of cotton plants dead from root rot. All 3 species were found to be strongly antibiotic to *P. omnivorum*. Hyphae from each of these 3 species of *Trichoderma* were found capable of parasitizing single hyphae or strands of *P. omnivorum*.

J. J. Taubenhaus.

Antagonism of *Rhizoctonia* to hyphae of *Phymatotrichum omnivorum*: It has been found that proximity of hyphae of *Rhizoctonia* in hanging-drop cultures to hyphae of *P. omnivorum* uniformly causes rapid deterioration of the latter. *Rhizoctonia* hyphae also caused rapid deterioration of hyphae of the unidentified Basidiomycete previously mentioned.

W. N. Ezekiel.

Cytology of host-parasite relations in *Phymatotrichum* root rot of cotton: The material used in this work was obtained by growing cotton seed under pure culture conditions in the laboratory. Sterile germinating cotton seeds were placed on agar and inoculated with pure-culture sclerotia of *P. omnivorum*. At various stages of infection, the roots were fixed, imbedded, sectioned, and stained for cytological study.

Before penetration takes place, the fungous hyphae form a more or less encircling weft around the outside of the rootlets, often intermingling with root hairs. Occasional hyphae may enter root-hair cells. Here and there over the surface of the root, individual hyphae penetrate the epidermal cells, and from there advance further inward into the cortex. Penetration and further invasion of the fungus is both inter- and intra-cellular. At the point of entry of a hyphal tip there is often more or less constriction at the point where the hypha goes through the cell wall. The peg-like infection tubes described for certain other parasitic fungi have not been observed for *P. omnivorum*. This may be considered evidence of the secretion by the fungus of a wall-dissolving substance which provides a chemical means of hyphal penetration.

From the cortex the invading hyphae penetrate the endodermis and after more or less ramification enter the pericycle and finally the tracheids of the central cylinder. In the tracheids the hyphae have been observed progressing longitudinally from cell to cell, sometimes

growing also through the pits in the lateral walls. This observation tends to uphold the early suggestion that *Phymatotrichum* may progress in a longitudinal direction along the root through the interior vascular tissue. Other evidences of this have come from longitudinal sections of roots infected at the tips. In such cases the fungous hyphae frequently grow more rapidly up the root through the central cylinder than through the cortex or along the outside of the epidermis. Eventually the entire root becomes filled with a tangled mass of branching hyphae so that only fragments of the cell walls of the invaded tissue remain. The fungus apparently secretes a toxic substance which acts upon the host cells sometimes considerably in advance of the invading hyphae.

G. M. Watkins.

Experiments on control measures

Cotton from X-rayed seed: In the fall of 1933 a small quantity of Startex cotton seed was x-rayed for one-half hour. These were planted at College Station in 1934, and the seed harvested and kept separately by individual plants. During 1935, one part of this seed was planted at Substation 16. Ninety per cent of the plants died from natural infection of *Phymatotrichum* root rot. Seeds were saved from the remaining apparently resistant plants for 1936 planting. In addition to natural infection, each plant during 1936 was copiously inoculated with *Phymatotrichum* root rot, using freshly infected cotton roots as the source of inoculum. By the end of the season only 123 out of about 8,000 inoculated cotton plants survived. The seeds from these plants were saved for the 1937 planting with the hope that they may have some resistance to *Phymatotrichum* root rot.

J. J. Taubenhaus, G. M. Watkins, C. H. McDowell, L. E. Brooks.

Resistance of grapes to *Phymatotrichum* root rot: This work at Substation No. 16 was begun in 1934 when the following varieties were planted in infested land: Champanel, Lomanto, Lukfata, Black Spanish, Dogridge, La Pryor, *Vitis champini*, *V. cinerea*, and *V. rupestris*. Losses from *Phymatotrichum* root rot during 1936 occurred in practically all of the varieties planted, but of these Champanel and Dogridge showed considerable tolerance to root rot. *Vitis champini*, which hitherto has been considered resistant, had by 1936 completely died out from *Phymatotrichum* root rot.

C. H. McDowell, L. E. Brooks.

Susceptibility of apple varieties to *Phymatotrichum* root rot: Of 34 varieties of apples tested at Substation 16, none proved to be resistant. However, some varieties lasted longer than others, and these are considered worthy of further trials. The following were highly susceptible and died within 2 to 3 years: Early Red Bird, Stark's

Delicious, Grimes Golden, Giant Geniton, Mammoth Black Twig, Wealthy, Stayman Winesap, York Imperial, Winesap, and Diadem. The following survived about 4 years: Baldwin, Jonathan, King David, Liveland Raspberry, Paragon Winesap, Red Rome Beauty. The following survived about 5 years: Golden Delicious, Early Melon, Early Harvest, Henry Clay, Northern Spy, Rome Beauty, Black Ben, Becker, Bismarck, Dark Red Rome Beauty, and Oporto. The following survived for 6 years: Baldwin, Double Life Grimes Golden, McIntosh Red, Helm, and Translucent Crab. The following appeared most resistant and survived for 7 years: Senator and Gilbert Winesap.

J. J. Taubenhause, C. H. McDowell, L. E. Brooks.

Control by long rotation with sorghum: In 1933 an experiment was started at Waco to determine the possibility of controlling *Phymatotrichum* root rot by long rotations with sorghum or other grain crops. This work was continued in 1934, 1935, and 1936, with the same land devoted to sorghum during the entire period. During 1936, after four years in sorghum, 10 random posthole auger samples from this field yielded 2,070 sclerotia with a germination of 52 per cent. The same land will be devoted to sorghum or a grass crop for several years, or until the viability of the sclerotia in that field is exhausted.

J. J. Taubenhause.

Effect of continuous cropping of sorghum on root rot: This report is included under Substation No. 5.

Clean fallow as affecting root rot: This report is included under Substation No. 5.

Rotations as affecting viability and distribution of sclerotia: This report is included under Substation No. 5.

Control of root rot by long rotations with sorghum: See Substation No. 16 report.

Effect of certain chemicals in the production of cotton and cowpeas in root-rot areas: This report is included under Substation No. 5.

Barriers to prevent spread of *Phymatotrichum* root rot

Graminaceous crop barriers to prevent the spread of root rot: As reported in previous years 3 sorghum rows were planted in 1931 as a barrier to prevent the encroachment of root rot from an inoculated cotton plat into an immediately adjoining uninoculated cotton plat. Identical plantings were made in 1932, 1933, 1934, 1935, and 1936. High percentages of the cotton plants in the infested plat died from *Phymatotrichum* root rot during each of the 6 years of this experiment, while cotton plants in the adjoining uninoculated plat but separated by the sorghum barrier have remained normal. A few rows of sorghum

are thus able to act as a perfect barrier to prevent spread of *Phymatotrichum* root rot from an infested to a noninfested cotton area.

J. J. Taubenhause.

Sulphur slabs to prevent spread of *Phymatotrichum* root rot: During 1933 an experiment was started in which sulphur slabs 4 ft. x 4 ft. and 1½ inches thick were used as barriers to prevent the spread of *Phymatotrichum* root rot from an infested to a non-infested area. The method of using the sulphur slabs was described in earlier reports. The results secured during 1936 were similar to those obtained during 1934 and 1935, showing that neither cotton roots nor the strands of *P. omnivorum* are able to go through a sulphur slab into a root-rot-free zone.

J. J. Taubenhause.

Immunizing plants by acidifying the cell sap: In an effort to protect highly susceptible trees against *Phymatotrichum* root-rot infection, attempts have been made to increase the acidity of the cell sap of chinaberry trees to such a degree that *Phymatotrichum* will be unable to penetrate the roots. A weak solution of sulphuric acid (1 part concentrated acid to 4,000 parts water) was injected into the trunks through funnels attached to glass tubes which were inserted into the trunks of the trees. Distilled water alone was injected into the trunks of other chinaberry trees as checks. All the funnels were kept supplied with acid or water for a period of about 10 months. An average of 14,266 cc of weak acid solution was added to each experimental tree used in this experiment, and 10,566 cc of water to each check. The check trees, as well as those injected with sulphuric acid solution, died from *Phymatotrichum* root rot. Preliminary determination of the pH of the cell sap of the check and treated trees showed no change in cell sap acidity from the acid treatment. In another experiment, sulphuric acid (1 to 4,000 of water) was applied to the soil surrounding the roots of 5 chinaberry trees at the rate of 420 quarts per week. Ordinary tap water was added to the soil of the check trees at the rate of 336 quarts per week for the 4 trees. One of the check trees receiving water has died from root rot; the remaining three check and the five experimental trees are still alive. The experiment will be continued until sufficient time has elapsed to afford a test of the protection derived by the trees from the application of sulphuric acid to the soil.

G. M. Watkins, J. J. Taubenhause.

Tomato diseases

Are spotted wilt and dwarf mosaic seed-borne? Seeds were collected in November, 1935, from fall-grown Winter Garden tomato plants with spotted wilt and dwarf mosaic, respectively. In laboratory tests, 88 per cent germination was obtained from the seed of plants with spotted wilt, and only 4 per cent from seed of plants with dwarf mosaic. Seedlings from each lot of seed were planted in the field at College

Station and at Jacksonville, Texas. Frequent observations of these plants to the end of the growing season failed to reveal symptoms of either spotted wilt or dwarf mosaic. These diseases are probably not seed-borne.

G. E. Altstatt, P. A. Young.

Virus diseases of tomato: During 1936, a survey of virus diseases affecting tomatoes was made in the Lower Rio Grande Valley, in the Winter Garden, and in the vicinity of Robstown, San Antonio, and Laredo. The following virus diseases were observed affecting tomatoes: mosaic, fern leaf, filiform leaf, spotted wilt, rugose mosaic, crinkle, leaf roll, bunchy top, curly top, and dwarf mosaic.

Hosts of spotted wilt of tomatoes: During 1936, a survey was made of the hosts in Texas susceptible to spotted wilt. A preliminary list of affected hosts follows: *Amaryllis belladonna*, *Calendula officinalis*, *Datura tatula*, *D. meteloides*, *Dahlia* sp., *Gloxinia speciosa*, *Lactuca sativa*, *L. graminifolia*, *L. canadensis*, *Lobelia cardinalis*, *L. splendens*, *Lupinus subcarnosus*, *Mathiola incana*, *M. bicornis*, *Pelargonium graveolens*, *P. domesticum*, *Schizanthus pinnatus*, *Senecio cruentus*, *Zantedeschia aethiopica*, *Z. albo-maculata*, *Z. rehmannii*, and *Zinnia* sp.

Hosts to fern leaf mosaic: The following Texas plants were found to be common carriers of fern leaf mosaic of tomato: *Amaranthus retroflexus* and *Phytolacca decandra*.

Hosts to curly top of tomato and spinach: In view of the severe outbreak in Texas of curly top of tomatoes and spinach during 1936, an attempt was made to determine if possible the various Texas hosts which are susceptible to this disease. A survey was undertaken in which most of South Texas was included. A preliminary list of infected hosts follows: *Amaranthus caudatus*, *A. tricolor*, *Atriplex arenaria*, *A. lentiformis*, *A. patula*, *Barbarea vulgaris*, *Capsicum frutescens*, *C. grossum*, *C. annuum*, *Cefosia argentea*, *C. argentea cristata*, *Cucumis melo*, *C. sativus*, *Dianthus barbatus*, *D. caryophyllus*, *Eschscholtzia californica*, *Gomphrena globosa*, *G. nitida*, *Ipomoea batatas*, *I. trifida*, *I. pandurata*, *Lobelia cardinalis*, *L. inflata*, *L. spicata*, *Lycopersicum esculentum*, *Nicotiana longiflora*, *N. rustica*, *Oxalis corniculata*, *O. stricta*, *O. violacea*, *Papaver nudicaule*, *P. orientale*, *Phaseolus latifolius*, *P. lunatus macrocarpus*, *P. vulgaris*, *Ranunculus fascicularis*, *R. pusillus*, *R. sceleratus*, *Solanum carolinense*, *S. melongena*, *S. nigrum*, *S. rostratum*, *S. tuberosum*, *Tropaeolum majus*, *T. minus*, *Viola odorata*, and *V. tricolor*.

J. J. Taubenhaus, G. E. Altstatt.

Tomato seed carriers of Fusarium wilt: Previous work by Taubenhaus has shown that tomato wilt, *Fusarium lycopersici*, may be carried in seed from wilt-infected plants. During 1936, ten whole plants with definite symptoms of wilt were collected at Jacksonville, Texas. Cultures from portions of the roots, stems, and fruit peduncles yielded respectively 51 per cent, 46 per cent, and 30.2 per cent of colonies of *Fusarium lycopersici*. Isolations from the seeds are as yet incomplete.

J. J. Taubenhaus, G. E. Altstatt, P. A. Young.

Preparation of large-scale field inoculum of *Fusarium lycopersici*: In an attempt to develop a strain of tomatoes resistant to *Fusarium* wilt, *Fusarium lycopersici*, it was necessary to incorporate into the soil large amounts of inoculum of the tomato wilt fungus. After several trials, a method was adopted using 1-gallon and 5-gallon tins of sterilized oats. After the fungus had been introduced and had become established on the oats, these were spread between alternate layers of moist soil. In this manner, a large quantity of inoculum was made available for field use.

G. E. Altstatt.

Viability of *Fusarium lycopersici*: Wilt-infected tomato plants were collected during September, 1933, and stored in an open shed at College Station. Cultures were made of this material at different intervals and found to be viable during 1933, 1934, and as late as May, 1935. Further cultures from the roots of one of these plants yielded viable cultures as late as January, 1936. Subsequent cultures made in September, 1936, yielded no growth. From work thus far, it seems that the fungus *Fusarium lycopersici* is able to survive in the dried tissue of infected tomato plants for over two years. During 1936 more tomato plants infected with *Fusarium* wilt were secured from Jacksonville, Texas, to recheck the work above mentioned.

G. E. Altstatt, P. A. Young.

Selection for *Fusarium* wilt resistance in tomatoes: The work of selection of strains of tomatoes for resistance to *Fusarium* wilt was discontinued during 1936. This was due to the fact that during 1935 and 1936, the soil became thoroughly infested with *Sclerotium rolfsii*, which destroyed all the selections which were planted on this land. *Sclerotium rolfsii* has proved a serious factor in this type of work with tomatoes and before any progress can be made it will be necessary to use an effective and cheap soil disinfectant capable of destroying not only *Sclerotium rolfsii* but also nematode, *Caconema radicum*.

H. F. Morris, G. E. Altstatt.

An attempt to produce a wilt-resistant tomato by X-ray: Seeds of Marglobe tomatoes were secured early in the fall of 1933 and x-rayed. In the spring of 1934, the seeds were planted at College Station on land free from soil-borne diseases, and a fair crop of seed was harvested. During 1935, half of the seed were planted on land heavily infested with *Fusarium* wilt, *Fusarium lycopersici*, but practically all the plants were killed by Southern blight, *Sclerotium rolfsii*. The other half of the seed which were not used during 1935 were planted at Jacksonville, Texas, during 1936. The plants from these seeds were put out on land heavily infested with *Fusarium* wilt. At the end of the season only 27.4 per cent of the plants from the X-rayed seed were infected by *Fusarium* wilt, whereas the plants from non-X-rayed Marglobe tomato seeds gave an average percentage of 60.6 to 66.5 per cent of plants infected by *Fusarium* wilt. This work will be continued.

J. J. Taubenhaus, P. A. Young, G. E. Altstatt.

Susceptibility of tomato varieties to *Fusarium lycopersici*: Given in report of Substation No. 11.

Attempts to secure wilt-resistant varieties of tomatoes: Given in report of Substation No. 11.

Viability of *Sclerotium rolfsii*: Sclerotia of *S. rolfsii* in soil cultures in lamp chimneys were buried in a field at College Station at depths of 10 and 16 inches. The soil surrounding some of the lamp chimneys was kept dry, while around others the soil was kept moist. The sclerotia in the lamp chimneys buried 10 inches remained viable longer than those 16 inches deep, regardless of the amount of soil moisture.

G. E. Altstatt.

Crown rot and stem canker: A canker disease of fall-grown tomatoes was found to cause heavy damage to young plants grown in the Winter Garden section, in the Laredo district, and to a limited extent in the Lower Rio Grande Valley. Infected plants are readily recognized by their stunted yellow sickly appearance, with numerous dark to chocolate-colored depressed cankers at the crown or on any part of the stem above. During the cooler fall weather of 1936, affected plants have almost completely outgrown the original infection. A number of organisms were recovered from cankered tissue. They are, in order of frequency of occurrence: *Alternaria* sp., *Helminthosporium* (two species), *Phoma destructiva*, and bacteria. Which of these organisms or combinations of these organisms cause the disease has not been determined.

J. J. Taubenhaus, G. E. Altstatt.

Anthrachnose: A few fall-grown tomatoes from the Winter Garden developed soft spots covered by minute black bristly bodies which were found to be pycnidia of a fungus identified as *Vermicularia* sp. Successful inoculations were made on a small number of normal green tomato fruits with hyphae and spores from a pure culture of this organism. Taubenhaus reported *Vermicularia dematium* as causing a rot on tomato fruit secured from East Texas in 1935.

G. E. Altstatt.

Myrothecium on tomatoes: Two new strains of a fungus identified as *Myrothecium* species have been obtained from tomatoes, one from a decayed spot on a fruit, the other from a stem-canker. These two, and the fungus *Myrothecium roridum* isolated from snapdragons, were inoculated into normal tomato fruits for comparison. The symptoms produced by each were entirely distinct. The 3 organisms also produce distinctly different colonies when grown on nutrient agar. In view of these differences and also the fact that *M. roridum* is only weakly parasitic on tomato fruits, the two new strains are probably to be considered distinct species.

J. J. Taubenhaus, G. E. Altstatt.

Effect of medicated wraps or dips on the control of storage rots of tomatoes: A series of experiments was conducted on the control of fruit rots affecting "green-wrap" tomatoes during storage. Fruits were obtained at Carrizo Springs and at Jacksonville, treated with various chemical dips as disinfectants, and wrapped in medicated or chemical-

impregnated paper wraps. A few of the more effective control measures follow: A single test with uncoiled paper wraps impregnated with 1½ per cent copper salt plus 4 per cent sulphur gave very effective control of fruit decay. Tomatoes wrapped in iodized paper wraps covered by an outside wrap of moisture-proof cellophane (300 MT) appeared to control decay better than iodized wraps alone, or cellophane wraps alone. Paper wraps impregnated with 1½ per cent copper salt with or without oil also gave promise of controlling decay. Solutions of borax or Sulfoxide were not found satisfactory as dips when used alone or with medicated wraps. Tomatoes rolled in dry wettable sulphur or in Cuprocide or in a combination of both generally showed less decay than the untreated checks.

J. J. Taubenhaus, G. E. Altstatt.

Aspergilli causing tomato fruit rots in storage: Numerous strains and species of *Aspergillus* were found on decayed tomatoes in storage. These organisms,* arranged in the order of their frequency, are: *Aspergillus flavus* (strain producing no sclerotia), *A. flavus* (a strain producing large scattered sclerotia with a less purplish color and limited conidial areas), *A. flavus* (with abundant purplish sclerotia with large drop of water of condensation about the sclerotia), *A. luteo-niger* (vesicles large, easily breaking, stalks 17-20 microns in diameter, walls rather thin, spore heads from 400 to 500 microns, very black to the naked eye; conidia 4 microns or larger, rough breaking very readily), *A. tamarii*, *A. terreus*, *A. ochraceus* (produces no sclerotia, has short stalks), *A. niger* (produces big heads 400 microns or more, long stalks, walls rather thin, long primaries 60 microns, conidia 3 to 3.5 microns), *A. nidulans* (produces highly ornamental ascospores).

G. E. Altstatt, J. J. Taubenhaus.

Control of diseases of fall-grown tomatoes: This work was carried out in the Winter Garden section. In spite of frequent rains which washed off the dusts used, *Alternaria* and *Septoria* leaf spots were effectively controlled by dusting with 300-mesh Spider brand sulphur or sulphur in combination with either Cuprocide, calcium arsenate, or basic copper sulphate and pyrethrum.

Considering fruits of marketable size only, little difference was observed between tomatoes from dusted and undusted plats; but in normal fruits which were under marketable size the dusting appeared to cause an increase in yield.

G. E. Altstatt, J. J. Taubenhaus.

Control of damping-off of tomato seedlings: The per cent of germination and number of healthy plants developed from tomato seed treated with Ceresan or Cuprocide were much higher than that from untreated seed.

G. E. Altstatt.

Chemical soil treatments to control nematode: Given in report of Substation No. 11.

*Identifications made by Dr. Thom of the U. S. Department of Agriculture.

Effect of certain sprays or dusts on the foliage or fruit of tomatoes: Given in report of Substation No. 11.

Chemical soil treatments to control damping-off of tomato seedlings: Given in report of Substation No. 11.

Effect of light in controlling damping-off of tomato seedlings: Given in report of Substation No. 11.

Chemical seed treatments to control damping-off of tomato seedlings: Given in report of Substation No. 11.

Rose diseases

Studies on *Diplodia* die-back: Observations in East Texas indicated considerable differences in the susceptibility of varieties of roses to die-back. Varieties apparently resistant were: Radiance, Etoile de Hollande, Edith Nellie Perkins, Lady Hillingdon, Antoine Rivoire, Johanna Hill, Kaiserin A. Viktoria. Varieties moderately susceptible were: Talisman, President Herbert Hoover, Angelus, C. K. Douglas, and Francis Scott Key. Highly susceptible varieties were: Pierre S. Du Pont, Souvenir, Georges de Pernet, A. R. Briarclough, Governor Alfred E. Smith, and Luxembourg.

Isolations from infected plants yielded the following fungi: *Diplodia* sp. from 23.8 per cent of the bits of infected tissue cultured; *Phomopsis* sp. from 8.1 per cent; *Pestalozzia* sp. from 5.2 per cent; *Phoma* sp. from 1.8 per cent; and *Botrytis* sp. from 1.3 per cent. Most of the *Diplodia* isolations were obtained during July, August, and September.

Diplodia sp. recovered from rose canes reproduced the disease in both field and laboratory inoculations. *Pestalozzia* sp. and *Phomopsis* sp. caused infection in the laboratory, but not under field conditions.

Various species of *Diplodia* obtained from roses, oak, corn, walnut, grapefruit, Nabalus, Bryophyllum, fig, peanut, sweet potato, and cotton, and a species of *Physalospora* from rose, were used to inoculate open blooms of Luxembourg roses. Most of the organisms killed the flowers and advanced into the main stem.

Rose canes affected by die-back were collected and stored in an open shed in September, 1934. Isolations made at irregular intervals during 1934 and 1935 yielded large percentages of *Diplodia*. During 1936, 26.5 per cent of the bits of infected tissue yielded colonies of *Diplodia*.

Experiments on the control of die-back included disbudding, spraying, and dusting. The work was carried out with Luxembourg at College Station and at Substation No. 2, and with Dame Edith Helen and President Herbert Hoover at two commercial nurseries. Only slight reduction in die-back resulted when the plants were sprayed with 3-3-50 Bordeaux plus 5 pounds wettable sulphur or when dusted with a mixture con-

sisting of 10 parts 300-mesh Spider brand sulphur, 1 part Cuprocide, and 1 part lead arsenate. Disbudding reduced die-back from 10.15 per cent in the check plats to 1.21 per cent in the pruned plats.

G. T. Boyd.

Control of black spot of roses: Good control of black spot was obtained with 16 applications of a dust made up of 10 parts 300-mesh Spider brand sulphur, 1 part Cuprocide, and 1 part arsenate of lead; or with a 3-3-50 Bordeaux spray to which was added 5 pounds of wettable sulphur. Good control was secured also by dusting or spraying with Spider brand sulphur in combination with the following coppers: Cuprocide, basic copper sulphate, or copper powder RL 500. Somewhat better control of black spot was secured when Spider brand sulphur plus Coposil or copper KB were used as a spray than when the same materials were used as a dust.

In an experiment at College Station, Cuprocide used on Luxembourg roses up to 7 per cent in combination with Spider brand sulphur and up to 17 per cent with fullers' earth did not cause appreciable foliage injury. No foliage burn occurred to Luxembourg roses sprayed with 4 pounds Cuprocide in 50 gallons of water.

G. T. Boyd.

Studies on black spot: Observations were made on the relative susceptibility of rose varieties to black spot. In general, the more resistant varieties were: Francis Scott Key, Etoile de Hollande, Briarcliff, Charles P. Killham, and Antoine Rivoire. Moderately susceptible varieties were: Hadley, Ophelia, White Killarney, E. G. Hill, and Radiance. Among the highly susceptible varieties were: Pierre S. Du Pont, Julien Potin, Angelus, Golden Dawn, Luxembourg, and Sunburst.

At College Station, the first black spot infection on Luxembourg roses was observed on April 1, 1936. By May 1, 21 per cent of the leaves were infected, and a maximum of 40 per cent infection was reached by June 1. By June 15, heavy shedding of foliage had occurred, due presumably both to black spot infection and dry weather; and by the end of June infection was reduced to 2.2 per cent. At this point, the plants began to put out new leaves, and black spot infection increased to 11.6 per cent by August 1. After this date, further shedding of the foliage occurred and black spot infection decreased to 6.9 per cent by September 1. New leaves were again produced in the middle of September, and by October 1, black spot infection had increased to 16.9 per cent. Partial defoliation again occurred, and on November 1, 8.5 per cent of the leaves showed black spot infection.

G. T. Boyd.

Seasonal prevalence and viability of spores of black spot: Rose leaves infected with black spot, *Actinonema rosae*, were collected at College Station at monthly intervals from January to December, 1936, inclusive, and a count made of the spots on the foliage of 10 plants. It was found that the greatest percentage of leaf infection occurred during January, February,

May, June, October, November, and December. The smallest number of leaf spot infections was found during July, August, and September. High percentages of germination, ranging from 49 to 82 per cent, were secured from the material collected during January, February, March, April, May, and June. During July the percentage of germination dropped to 19 per cent, to 3 per cent in August, and to 5 per cent in September. The percentage of germination rose to 42 per cent in October, to 61 per cent in November, and to 81 per cent in December. This indicated that the viability of the spores of *Actinonema rosae* is probably affected by weather conditions.

J. J. Taubenhaus.

Inoculations with spores of *Actinonema rosae*: Rose leaves infected with black spot were collected at College Station during January, May, June, July, August, and September of 1936, placed in screened cages and exposed to weather conditions on the ground. Spore suspensions from those leaves collected before July were able to cause infection after one month's exposure. Spores produced during July, August, and September lost their viability after 5 to 9 days. Irrespective of seasons, best infection was secured from spores of freshly infected leaves.

J. J. Taubenhaus.

Adhesiveness of various fungicidal materials: Laboratory tests were carried out to determine the effect of additions of 14 different spreaders on the adherence of 4 different copper sprays to glass slides. A commercial spreader, SS 3, was most effective in improving the adhesive qualities of Cuprocide, increasing the per cent of copper adhering to the slide from 27.8 for Cuprocide alone, to 98 per cent for Cuprocide plus SS 3. Coposil adhered best with additions of dry Areskap or dry Ortho. The adherence of copper KB was increased by Kayso or Corikal N. powder. Copper Hydro 40 adhered fairly well alone, but adherence was improved by all spreaders, particularly Aresket 240, dry Ortho, and Corikal N. powder.

G. T. Boyd.

Defoliation: Good defoliation was secured with Paul's Scarlet Climber roses when sprayed with a solution consisting of 2 pounds of copper sulphate and 50 gallons of 0.5 per cent sulphuric acid. However, the same mixture was not so effective in causing defoliation on Etoile de Hollande. The sprayed Etoile de Hollande did not deteriorate in winter storage, indicating that the acid spray did not injure the canes.

G. T. Boyd.

Storage experiments: After 4½ months of storage in a non-refrigerated cellar, there seemed to be no significant difference in the number of cankered and decayed canes of plants that had been given the following treatments prior to storage: none; plants sprayed with 2 pounds of copper sulphate in 50 gallons of 0.5 per cent sulphuric acid; plants buried for 10 days in the ground.

Texas Centennial plants stored for 4 months in refrigerated storage survived through the 1936 season and appeared in better condition than similar plants stored 4 months in a non-refrigerated cellar.

G. T. Boyd.

Garlic diseases

Bacterial soft rot; its transmission: Cloves from selected soft-rot infected bulbs planted at College Station developed typical soft-rot infections during the growing season. Severely infected cloves planted failed to produce mature plants, the whole usually rotting in the soil before much growth was made.

The amount of bulb infection developed varied directly with the degree of infection of the original clove planted.

G. E. Altstatt.

Organisms isolated from infected bulbs: A number of organisms have been recovered from diseased garlic bulbs. The organism most commonly found on decayed bulbs was a bacterium causing a slimy soft-rot. While positive identification of this organism has not been made, it very closely resembles *Bacillus carotovorus*, the organism responsible for much of the soft-rot decay in many fruits and vegetables.

Other organisms isolated from diseased bulbs include: *Sclerotium bataticola*, *Trichoderma* sp., *Penicillium* sp., *Aspergillus* sp., *Helminthosporium* sp., *Sclerotium rolfii*, *Diplodia* sp., and a vinaceous *Fusarium*. The *Helminthosporium* was found inhabiting the outer scales of the young plants at Moulton; the fungus, *S. rolfii*, was common on mature bulbs at College Station, but not observed at Moulton. The *Diplodia* isolated from the dry outer scales of harvested bulbs has not been proved pathogenic, but inoculations into watermelons and grapefruit show it to be an active parasite different from *D. natalensis*.

J. J. Taubenhause, G. E. Altstatt.

Disinfection of garlic cloves to control disease: Mercuric chloride (1:1000) used as a dip for garlic cloves before planting was the most satisfactory means of controlling the various organisms attacking the garlic bulb. A 2 per cent solution of Fungicide 35AR538 and a 2 per cent ammonium hydroxide solution were also effective in reducing the amount of infection. While sulphur, Ceresan or Cuproside applied to the cloves as a dust gave fair control of the disease, they were somewhat toxic to the plants.

Sulphur at the rates of 400 and 800 pounds to the acre, applied in the furrow, was toxic, as was Cuproside when applied in like manner at the rates of 200 and 400 pounds per acre.

G. E. Altstatt, J. J. Taubenhause.

Artificial curing of garlic: As a means of preventing or arresting infection of the soft rot organism in harvested garlic, a small experi-

mental forced-hot-air dryer was constructed to cure the bulbs by rapid drying. A full description of this unit is given in the report of the Division of Agricultural Engineering.

Experiments conducted during the year indicated the following: that garlic bulbs are injured by temperatures of over 150°, the most satisfactory drying temperatures being from 100° to 130°F.

Garlic harvested before fully mature attains a pale greenish color after curing, and the badly infected bulbs become yellowed and brown.

J. J. Taubenhaus, G. E. Altstatt, H. P. Smith.

Milo diseases

The milo disease has been found in the following counties of Southwest Texas: Runnels, Tom Green, Taylor, Coleman, McCulloch, Concho, Coke, and Nolan. A similar disease is prevalent in Kansas where the cause was attributed to a species of *Pythium*.

Due to unusual rainfall, leaf spots caused by *Cercospora sorghi* and *Helminthosporium turcicum* caused severe foliage injury on various varieties of sorghums.

Red stripe caused by *Bacterium andropogoni* was unusually prevalent on various varieties of sorghum in many parts of Central and South Texas. There are evidences that the disease is seed-borne.

J. J. Taubenhaus.

Sorghum diseases

Studies on sorghum diseases have been made in cooperation with Mr. R. E. Karper. Isolations were made on several occasions from plants with crown rot; the material yielded mostly *Fusaria* and *Rhizoctonia*. Isolations from foliage of plants with "red-spot" and extensive firing, from the Angleton substation, showed that fungi were apparently involved as well as bacteria. Inoculation experiments have not yet been carried on with the organisms recovered in this work.

W. N. Ezekiel.

Fungicidal properties of sulphur and Cuprocide

Effect of sulphur or Cuprocide on the germination of spores of *Actinonema rosae*: In laboratory tests on slides, Copper Hydro 40 and basic copper sulphate used as sprays completely prevented germination of spores of *Actinonema rosae*; while Cuprocide, Copper KB, Coposil, and 3-3-50 Bordeaux were slightly less effective. Toxicity of Cuprocide, Coposil, and Bordeaux sprays was generally reduced by the addition of dry Ortho or Kayso. Dry Areskap, Areskap 50, and Aresklene were themselves effective in reducing germination of spores of *Actinonema rosae*; while other commercial spreaders tested apparently were much less effective.

In tests of dusts, 300-mesh Spider brand sulphur was toxic to spores of *Actinonema rosae*. With mixture usually of 85 per cent wettable sulphur or Spider brand sulphur, 10 per cent lead or calcium arsenate, and 3 to 5 per cent of various additional materials, additions of monohydrated copper sulphate, basic copper sulphate, copper RL 500, and Coposil were most effective; additions of Cuprocide, Copper KB, Copper Hydro 40, and Metrox were less effective; and copper phosphate and zinc oxide "AAZ" additions were still less effective.

J. J. Taubenhause, G. T. Boyd, Ethel Gelber.

Control of damping-off of cotton seedlings: Cotton seed previously delinted with sulphuric acid was divided into sinking and floating seed in water. These as well as the undelinted check seeds were dusted respectively with Cuprocide at 2, 3, 4, and 5 ounces per bushel of seed; Copper KB and Ceresan at 2 and 4 ounces; zinc oxide "AAZ" and copper phosphate at 2, 4, and 6 ounces; and wettable sulphur and 300-mesh Spider brand sulphur at 4 and 8 ounces. At College Station, no difference in stand was apparent from the use of any of these dusts, probably because the seeds were planted late in the season (May, 1936) at which time the soil was already warmed up. However, irrespective of the dust treatments, the more rapid emergence and better final stand was obtained from the acid delinted sinking seeds. At Waco, the best control of soreshin of cotton seedlings, *Rhizoctonia solani*, was secured with Cuprocide, Ceresan, or sulphur. Most soreshin occurred on seedlings from seeds treated with hydrated lime.

Control of damping-off of tomato seedlings: Best control of pre-emergence and post-emergence damping-off in flats was secured on seeds treated with 3/5 or 4/5 ounce Cuprocide per pound of seed, or with 3 ounces zinc oxide "AAZ" per pound of seed. The Cuprocide treatments of tomato seed increased the emergence to 224 per cent, and the zinc oxide "AAZ" increased emergence to 232 per cent that of the checks. Germination of tomato seed was apparently not affected by an excessive amount of Cuprocide or zinc oxide dusts.

Control of damping-off of spinach seedlings: Seed treated with 3/5 ounce Cuprocide gave an increase to 264 per cent germination as compared to germination of the checks. Seed treated with 1 ounce of zinc oxide "AAZ" gave an increase in emergence of 274 per cent that of the checks. Spinach seed treated with either Ceresan or sulphur decreased in emergence. Soil treatment with zinc oxide "AAZ" retarded post-emergence damping off of spinach, but the benefit was not lasting.

Adhesiveness of various dusts to spinach seeds: A fungicidal dust may be misjudged as to its ability to control damping-off if it has poor adhesiveness. Basic copper sulphate, wettable sulphur, and 300-mesh Spider brand sulphur consistently showed poor adhesiveness to spinach seeds. On the other hand, Cuprocide, Copper KB, Ceresan, zinc oxide "AAZ" Special, and copper phosphate "B" showed good adhesiveness.

In future work, the question of spreaders or stickers must be given consideration.

Control of cotton diseases: Weekly dusting of Startex cotton with mixtures of 8 parts 300-mesh Spider brand sulphur, 1 part Cuprocide or basic copper sulphate, and 1 part Paris green, greatly reduced damage by angular leaf spot *Bacterium malvacearum*, and *Cercospora* leaf spot, *Cercospora althaeina*. The dust containing Cuprocide gave an increase in yield of 144 pounds of seed cotton per acre and the dust containing basic copper sulphate gave an increase of 128 pounds of seed cotton per acre over the undusted checks.

Control of corn smut: Field corn dusted with a mixture containing 5 per cent Cuprocide showed some foliage burn but none with 3 per cent Cuprocide. A dust consisting of 3 per cent Cuprocide, 10 per cent lead arsenate, and 87 per cent 300-mesh Spider brand sulphur caused no injury to corn plants. There was no smut during 1936 on either dusted or undusted corn plants.

Control of *Cercospora* leaf spot of beets: As in 1935, *Cercospora* leaf spot, *C. beticola*, was effectively controlled by dusting with a mixture containing 80 per cent 300-mesh Spider brand sulphur, 10 per cent Cuprocide, and 10 per cent lead arsenate; or 80 per cent 300-mesh Spider brand sulphur, 10 per cent Paris green, and 10 per cent basic copper sulphate.

Foliage injury: Tomato, gladiolus, rose, cotton, calendula, marigold, arborvitae, carrot, vinca, queen's wreath, canna, cedar, pomegranate, crape myrtle, vitex, opuntia, beet, turnip, radish, cockscomb, and privet showed no foliage burn or injury when dusted during the 1936 season with a mixture consisting of 85 per cent 300-mesh Spider brand sulphur, 10 per cent arsenate of lead, and 5 per cent Cuprocide.

J. J. Taubenhaus, A. L. Burkett.

Control of fig diseases: Two serious leaf diseases, rust, *Cerotelium fici*, and leaf spot, *Cercospora fici*, were important during 1936. Best control of both diseases was secured with a 4-4-50 Bordeaux spray, plus 4 pounds wettable sulphur to each 50 gallons. Good control was also obtained by two seasonal sprays, with 5 pounds wettable sulphur, 1½ pounds Cuprocide, and 50 gallons of water.

J. N. Roney, J. J. Taubenhaus.

Field control of strawberry chlorosis: Chlorosis of strawberries grown in the Gulf Coast country was found to be caused by soil alkalinity (presence of calcium in the soil) and not by a virus. This work was started during 1934 and continued in 1935 and 1936. Sulphur was placed in the furrows at the rate of 500 pounds per acre, several weeks before planting. The results during 1936 were almost identical with those obtained in previous years. Chlorosis was practically controlled

and yields of marketable berries considerably increased in the plats receiving the furrow application of sulphur.

J. N. Roney, J. J. Taubenhause.

Control of potato scab: This is a continuation of work carried on for the last 3 years in which sulphur was applied in the furrows at rates of 500 and 1,000 pounds per acre. Good control of potato scab and increases in yields and quality of tubers were secured in the plats receiving the furrow application of sulphur. Fair to good control of potato scab was also secured when the seed pieces were rolled in sulphur previous to planting.

J. J. Taubenhause, J. N. Roney.

Field control of citrus diseases: This work was a continuation from the last 2 years and was carried out at the Engelman Gardens at Elsa. The results are based on an examination of 200 grapefruit per plat at the time of harvesting. In this work, a comparison was made of the effectiveness of sulphur dusts with that of sulphur sprays. However, the results were inconclusive due to a scarcity of grapefruit diseases during 1936. On the whole, best control of citrus scab, *Sphaceloma fawcettii*, was secured with a combination dust of sublimed and ground sulphur, or a spray consisting of 4-4-50 Bordeaux plus 5 pounds wettable sulphur to each 50 gallons of the Bordeaux. Good control of scab was also secured by other sprays consisting of either 1 per cent lime-sulphur, 2 pounds aluminum sulphate, 3 pounds wettable sulphur, and 100 gallons of water, or 2 per cent lime-sulphur, 2 pounds aluminum sulphate, and 100 gallons of water.

W. J. Bach.

Effect of medicated wraps, medicated dips, sulphur, and sulphur compounds on the control of citrus decay in storage: Light and heavy dusting by rolling of grapefruit in 300-mesh Spider brand sulphur dust gave fair control of decay during a 24-day storage period; however the results were erratic in longer storage periods. Fair control of grapefruit decay was secured with the following medicated paper wraps arranged in order of effectiveness: iodized wraps, wraps impregnated with 1 per cent copper resinate, and wraps impregnated with 2 per cent copper sulphate and 17 per cent oil.

Grapefruit dipped in a 10 per cent solution of sulphuric acid for various exposures was seriously injured from acid burn. Even a 5 per cent solution of sulphuric acid with an exposure of only 1 to 3 minutes resulted in severe acid burn. Grapefruit dipped in an 8 per cent borax solution or in a 0.6 per cent Sulfocide solution suffered heavy losses from decay in these tests.

J. J. Taubenhause, G. E. Altstadt.

Sulphur bricks: In previous years, sulphur bricks were successfully used in sidewalks to control nutgrass. The results during 1936 were just as outstanding. The sulphur brick sidewalks laid during 1933

remained well preserved during 1934, 1935, and 1936. Moreover, the nutgrass was completely controlled as a result of these bricks, which, however, is not the case with ordinary bricks.

In addition to sulphur bricks in sidewalks, an experiment was tried during April, 1936, in which a strip of ground heavily infested with nutgrass was given a surface application of a 200-mesh sulphur at the rate of one pound per square foot of space, then carefully spaded under to a depth of 6 inches. As a result of the treatment, the nutgrass quickly turned reddish, then white, and by June, 1936, an interval of two months, was all dead, whereas in the untreated plat the nutgrass continued strong and viable.

J. J. Taubenhaus.

Fungicidal properties of sulphuric acid

Effect of sulphuric acid dilutions on the control of rice weeds: Preliminary work was carried out during 1936 on the value of sulphuric acid solutions on the control of rice weeds. A 5 per cent acid solution injured many of the rice weeds but not the rice seedlings nor any of the grass weeds. A 10 to 15 per cent solution killed many of the weeds, particularly the Mexican weed, *Caperonia palustris*. A 10 per cent solution killed rice seedlings down to about $\frac{1}{3}$ and 15 per cent solution to about $\frac{1}{2}$ of the height of the untreated plants. The grasses were injured in the same manner as the rice plants. The injured rice seedlings recovered quickly, made new growth, and eventually were thriftier than the untreated plants. Definite increases in yield were secured in all plats sprayed with sulphuric acid, particularly when the spraying was carried out early in the season.

J. J. Taubenhaus, R. H. Wyche.

Sulphuric acid as a weed killer: The following plants were apparently killed by a single spray with 10 per cent sulphuric acid: *Medicago denticulata*, *Melilotus officinalis*, *Castilleja indivisa*, *Oenothera speciosa*, *Ambrosia* spp., *Vicia texana*, *Erigeron philadelphicus*, *Geranium carolinianum*, *Galium aparine*, *Schrankia* sp., *Oenothera laciniata*, *Linaria canadensis*, *Sonchus arvensis*, *Modiola caroliniana*, *Chaerophyllum teinturieri*, *Lepidium virginicum*, *Rumex crispus*, *Rumex hastatulus*, *Solanum* spp., *Oxalis stricta*, *Rubus* sp., *Sanicula floridana*, *Rumex altissimus*, *Lippia nodiflora*, *Capsella bursa-pastoris*, *Erigeron canadensis*, *Ipomoea hederacea*, *Isopappus divaricatus*, *Heterotheca subaxillaris*.

The following monocotyledonous plants were not permanently injured by a single spray with 10 per cent sulphuric acid: *Cynodon dactylon*, *Setaria occidentalis*, *Sorghum halepense*, *Bromus unioloides*, *Phalaris caroliniana*, *Andropogon* spp.

Effect of various dilutions of sulphuric acid on foliage of plants: Before testing dilutions of sulphuric acid as fungicides for various plants, it seemed desirable to determine the tolerance of different plants to single applications of acid solutions of various strengths, generally

using a spreader in the spray solution. Mature corn plants were not injured by 0.5 per cent acid, but were injured by 2 per cent and above. Corn seedlings 6 inches high were not injured by 0.1 per cent acid, but were seriously affected by 0.2 per cent. Foliage and stems of the following plants were not injured by 0.1 per cent, but were injured by 0.2 per cent acid: 1-month old sweet potato plants, Surecropper stringless beans, Hale's Best cantaloupes, soybean seedlings, okra seedlings, and Startex cotton seedlings. The following plants were not injured by 0.1 per cent, but were injured by 0.3 per cent acid solution: foliage of mature beet plants, leaves of mature carrots, young twigs and leaves of pomegranates, stems and foliage of Marglobe tomatoes, and canes and foliage of Polyantha roses. Stems and foliage of mature asparagus plants and Crotalaria seedlings were not injured by 0.2 per cent but were injured by 0.5 per cent acid. Young potato plants were injured by 0.5 per cent acid, while young stems and leaves of grapes, mature garlic plants, sorghum seedlings, and squash seedlings were not injured by 0.5 per cent but were injured by 1 per cent solution.

Fungi and bacteria recovered from cotton seeds delinted with sulphuric acid: Seeds from cotton bolls with boll rot, caused by *Bacterium malvacearum*, and seeds from apparently normal bolls were all delinted for 15 minutes in concentrated sulphuric acid. A portion was then treated also for 2 minutes with 1-1000 mercuric chloride solution in 50 per cent alcohol. Both lots were then rinsed and planted in Petri dishes on potato-dextrose agar. There was no noticeable difference in the kind and number of fungous or bacterial organisms recovered from the acid-delinted seed alone and the acid delinted seed plus the additional treatment. Organisms recovered included *Fusarium*, *Helminthosporium*, *Diplodia*, *Sclerotium*, *Glomerella*, and bacteria. There was no noticeable difference between the number of micro-organisms recovered from the delinted germinating and non-germinating seed.

J. J. Taubenhaus, D. C. Bain.

Germination and yields from acid-delinted cotton seed: When cotton seeds are delinted with sulphuric acid and washed with water, a certain percentage of the seed sink and the remainder float. Sinking cotton seed of the variety Startex gave increase in germination of 172 per cent as compared to untreated seed, or increase of 118 per cent as compared to delinted but floating seed. Plants from acid-delinted cotton seed dusted with Cuprocide were much freer from angular leaf spot, *Bacterium malvacearum*, than plants from undelinted seed.

J. J. Taubenhaus, A. L. Burkett.

Rice Diseases

Susceptibility of varieties of rice to black kernel: Five varieties of rice, Early Prolific, Fortuna, Blue Rose, Lady Wright, and Nira, were selected from 3 different rice sections of Texas. No appreciable differ-

ences in susceptibility to the black kernel disease were evident among these varieties. At the Beaumont substation, the following varieties were found equally susceptible to black kernel: : Acadia, Caloro, Cohosa, Delitua, Edith, Early Prolific, Fortuna, Honduras. Lola, L. W. 10, Nira, Rexoco, Shoemed, Storm Proof, and Supreme Blue Rose.

J. J. Taubenhause, R. H. Wyche.

Micro-organisms recovered from unpolished rice affected by the black kernel disease: Over two thousand infected rice kernels were cultured during 1936. The following organisms were recovered and arranged in order of prevalence: *Basisporium gallarum*, *Basisporium lunata*, *Brachyosporium oryzae*, *Cephalothecium roseum*, *Cercospora oryzae*, *Cladosporium herbarum*, *Curvularia lunata*, *Epicoccum neglectum*, *Fusarium minimum*, *Fusarium semitectum*, *Fusarium solani*, *Gibberella saubinetii*, *Helminthosporium oryzae*, *Hendersonia oryzae*, *Mycosphaerella oryzae*, *Nigrospora oryzae*, *Oospora oryzetarum*, *Phoma glumarum*, *Phyllosticta glumarum*, *Piricularia oryzae*, *Podosporiella verticillata*, *Rhizoctonia solani*, *Sclerotium bataticola*, *Sclerotium rolfsii*, *Septoria longispora*, *Septoria oryzae* (this is now recognized as a stage of *Helminthosporium sigmorum*), and *Trichoconis caudata*.

J. J. Taubenhause, R. H. Wyche.

Micro-organisms recovered from polished rice affected by black kernel disease: The kernels of a number of samples of infected polished rice were grouped into normal, slightly darkened, medium darkened, and typical black kernel classes. The largest number of fungi recovered were from kernels of medium to severe infection. However, the normal-appearing kernels were not entirely free from the disease. The organisms recovered were: *Curvularia lunata*, *Curvularia brachyspora*, *Helminthosporium oryzae*, *Trichoconis caudata*, *Basisporium gallarum*, *Fusarium* sp.

J. J. Taubenhause, R. H. Wyche.

Effect of various shock covers on the prevalence of black kernel disease: Rice shocks were left uncapped 10 days after shocking, then covered; others were left uncapped throughout the experiments; others were covered by a Crowley cap for 10 days after shocking; others were covered by a Crowley cap throughout the season; while still others were covered by an ordinary cap for 10 days only. Representative samples of rice kernels were brought into the laboratory and examined for presence of the black kernel disease under these conditions of storage. Very little difference could be noticed in the amounts of black kernel disease in the respective shocks, indicating that black kernel disease originates in the field before harvest.

J. J. Taubenhause, R. H. Wyche.

Black smut: During 1936 an outbreak of black smut occurred on Patna rice in the Rosharon territory. Black smut, *Tilletia horrida*, is reported from South Carolina, Georgia, Louisiana, and Arkansas. This is the first record of its occurrence in Texas. Infected kernels lack the color present in normal kernels, are light in weight, and filled with a black smutty powder consisting of countless numbers of spores. This

disease was probably introduced with infected seeds. Attempts to germinate the spores of this fungus have as yet failed.

J. J. Taubenhaus, R. H. Wyche.

Rice weeds: The following weeds are common in numerous rice fields in Texas: Mexican weed, *Caperonia palustris*; curly indigo, *Aeschynomene virginica*; barnyard grass, *Echinochloa crusgalli*; *Carex interior*; *Polygonum aplousanum*; *Verbesina alba*; *Macuillamia rotundifolia*; *Thyella tannifolia*; *Fimbristylis castanea*; *Nama ovatum*; and beakrush, *Rhynchospora macrostachya*.* These and other weeds not yet identified are studied as possible hosts to the various rice diseases.

J. J. Taubenhaus, R. H. Wyche.

Miscellaneous diseases

Verticillium wilt of cotton: In the 1927 report, a wilt disease of cotton was found in Houston clay soils in the vicinity of Ennis and Waxahachie, Texas. The wilt disease occurred in the same fields where cotton also died from Phymatotrichum root rot. As the cause was not known, the disease was temporarily named "Waxahachie wilt," because it was found to be distinct from old cotton wilt, *Fusarium vasinfectum*, so common in the neutral to slightly acid sandy soils of East Texas. Considerable work was continued on this disease, and during 1936 the cause of the disease was definitely determined to be due to *Verticillium albo-atrum*.

During 1936, cotton growers in the vicinity of El Paso sustained heavy losses from a cotton wilt greatly resembling the "Waxahachie wilt" and definitely determined to be caused by *Verticillium albo-atrum*. Likewise, wilted cotton plants grown in calcareous soils at Anthony, New Mexico, were received and cultured, and pure cultures of *Verticillium albo-atrum* recovered.

Ten infected cotton plants were secured from the vicinity of Waxahachie and cultures made from portions of roots, stems, boll peduncles, and the seeds from all the bolls. *Verticillium albo-atrum* was recovered from all parts of the roots, stems, and boll peduncles. Of the 1440 cotton seeds cultured from the ten plants, *Verticillium* was recovered from only 119 of the interior of the seeds, or 8.3 per cent, indicating plainly that *Verticillium* wilt of cotton may be seed-borne.

Pure cultures of *Verticillium albo-atrum* recovered from affected plants of cotton from Waxahachie, El Paso, New Mexico, and Tennessee showed some differences between these four strains and yet not striking enough to consider them distinct from each other.

J. J. Taubenhaus.

Testing wilt-resistant varieties of watermelons: During 1936 seeds of 2 wilt-resistant varieties of watermelons, Improved Stone Mountain No. 5

*Plants identified by Dr. John K. Small, New York Botanical Garden.

and Improved Kleckley Sweet No. 6, were secured from the Iowa Experiment Station and planted in a badly wilt-infested field in Navasota; the Tom Watson, a highly susceptible variety, was used as a check for comparison. The seed were planted in March, 1936, and due to heavy rainfall, the Improved Kleckley Sweet variety was a total failure, indicating its poor resistance to excessive moisture. The Improved Stone Mountain showed 80 per cent resistance to Fusarium wilt, *Fusarium nivium*, whereas the Tom Watson used as a check showed a susceptibility of over 90 per cent.

J. J. Taubenhauus.

Testing resistance of Iowa wilt-resistant watermelon varieties: Given in report of Substation No. 11.

Stem-end rot of watermelon: Inoculations made with a number of known species of *Diplodia* produced typical stem-end rot symptoms. *Diplodia natalensis* from peanuts and *D. natalensis* from grapefruit produced typical stem-end rot symptoms. A decay was secured with the following species of *Diplodia* but the symptoms were not typical of stem-end rot: *D. tubericola* from sweet potatoes, *D. crassulae* from *Bryophyllum*, *D. gossypina* from cotton bolls, *D. herbarum* from Nabalus, *D. rosae* from die-back of roses, *Diplodia* sp. from garlic, *D. salicina* from pussywillow, *D. zaeae* from ear corn, *Physalospora* sp. from die-back of roses, and *Sphaeropsis* sp. from apple leaves caused still less decay. Inoculation with *D. longispora* from *Quercus montana* and *D. sycina syconophila* from die-back of figs failed to produce infections when inoculated into watermelons. A full description of the results of these inoculations will be forthcoming in a paper now in preparation.

J. J. Taubenhauus.

Stem-end rot of citrus: Work during 1936 was undertaken to determine whether stem-end rot of citrus may be caused by one or more species of *Diplodia*. Typical stem-end rot of grapefruit was secured by inoculation with *Diplodia natalensis* originally recovered from grapefruit and *D. natalensis* from peanuts. The following species were able to cause decay of grapefruit but without typical stem-end rot symptoms: *Diplodia rosae* from die-back of rose, *D. crassulae* from *Bryophyllum*, *D. gossypina* from decayed cotton bolls, *D. longispora* from *Quercus montana*, *Diplodia* species from garlic bulbs, *D. tubericola* from charcoal rot of sweet potatoes, *D. zaeae* from decayed ear corn, *D. herbarum* from Nabalus, *D. salicina* from pussywillow, *D. sycina syconophila* from die-back of figs, and a *Diplodia* sp. from blossom-end rot of pomegranates. Closely related fungi such as *Sphaeropsis* sp. from apple leaves, and *Physalospora* sp. from die-back of rose canes were also able to cause a decay of grapefruit, but with symptoms distinct and unlike typical stem-end rot.

J. J. Taubenhauus.

Witches broom of peanuts: In a single field at Floresville, Texas, a number of peanut plants showed a peculiar witches broom effect and a proliferation at the crowns. Cultures were made of some of the affected parts but without any growth. Some of the affected specimens were sub-

mitted to Dr. G. Steiner, of the U. S. Department of Agriculture, who found two species of nematodes, *Acrobeles crossotus* Steiner and *Cephalobus* (*Acrobeloides*) *butschlii* de Man. Dr. Steiner doubted whether either of these was the cause of the trouble.

J. J. Taubenhause.

A fig decay: In several fig orchards in Galveston county a peculiar disease was found attacking figs in all stages of development. Infected material placed in moist chambers in the laboratory or cultured in Petri plates on potato-dextrose agar yielded almost pure cultures of a fungus, *Choanephora cucurbitarum*. The disease was readily reproduced in normal figs by inserting through needle pricks, spores from a pure culture of the fungus.

Choanephora cucurbitarum also causes a disease of squashes in Texas and most often it is found living on old portions of okra and cotton blooms or on decayed organic matter.

J. J. Taubenhause.

A hollyhock rust disease new to Texas: The common rust of hollyhock, *Puccinia malvacearum* Mont., has not as yet been found to occur in Texas. In the 1932 report, a hollyhock rust disease was reported for Texas as caused by *Puccinia heterospora* Berk. & Curt. During 1936, affected hollyhock leaves were secured from Sudan, Texas, affected by a typical rust, and the fungus was temporarily identified by Dr. John A. Stevenson as *Puccinia lobata* B. & C. *Puccinia lobata* is characterized by its long hyaline pedicels and the heavy preponderance of two-celled teliospores.

J. J. Taubenhause.

Bloom blight of Easter lilies: In a commercial greenhouse at Houston, Easter lilies, *Lilium longiflorum*, were affected by a blossom blight at a time when the blooms should have been ready for market. The disease was characterized by sunken reddish spots or streaks on any part of the corolla, on the stigma, and anthers, or on the leaves immediately below the blooms and occasionally also on the stems. A number of cultures were made of the infected tissue, and a pure growth of a *Fusarium* was recovered in practically all of the plates. The disease was reproduced by spraying normal plants and blooms of Easter lilies with a spore suspension of the fungus. The symptoms on the artificially inoculated plants were similar to those of the naturally infected plants. The fungus was again recovered from the artificially inoculated blooms as well as leaves. This *Fusarium* has not yet been identified.

J. J. Taubenhause.

A blossom-end rot of pomegranates: During the summer and fall of 1936, a serious blossom-end rot destroyed the fruit of young and mature pomegranates at College Station and at Bryan, Texas. The trouble appeared as a decay of the corolla which gradually worked downward and involved one-half or more of the fruit. Cultures of infected tissue yielded a fungus resembling *Diplodia* in which Phoma-like spores, and macrospores appeared formed in the same pycnidium of the fungus. Bits

of pure culture hyphae inserted in normal pomegranate fruit caused a decay typical of stem-end rot. The same fungus is also able to cause a decay on grapefruit. J. J. Taubenhaus, Ethel Gelber.

Effect of X-ray on Texas bluebells: An attempt was made to develop a strain of Texas bluebells resistant to blight, *Sclerophoma eustomonis*. Seeds of Texas bluebells were secured from a grower in Dallas, Texas, and x-rayed. These seeds were returned to the owner who planted them during 1935 from which about 169 plants were raised, and only 42 of which matured seed that were saved and planted during 1936. From these, 455 second generation plants were grown, many of which were destroyed by *Sclerophoma* blight, and only 2.6 per cent of the plants were actually free from infection and appeared to possess resistance to *Sclerophoma* blight. The seeds of these apparently resistant plants were stored for planting during 1937. In this connection, considerable variation was noted in the plants from the second generation X-rayed seed, particularly in the color of the blooms. Some always had pure white throats with dark centers and rims, while others had dark reddish centers, and a few others had small daisy-like blooms, all of which offer commercial promise. J. J. Taubenhaus.

Black bundle disease of corn: Black bundle disease of corn caused by *Cephalosporium acremonium*, was quite widespread during 1936 and its damage was mistaken for drouth injury. The disease was found in the following counties: Smith, Cherokee, Anderson, Brazos, Grimes, Robertson, and Webb. Its distribution is probably more widespread in Texas than is at present known. Black bundle disease of corn was probably introduced with infected seed. J. J. Taubenhaus, P. A. Young.

Mulberry swells: The "pop-corn" disease, *Sclerotinia carunculoides*, of mulberry fruit was unusually prevalent during 1936. It was noted that birds of various kinds fed on normal and on infected berries. It is probable that the fungus is thus spread about by the fecal droppings of various birds. J. J. Taubenhaus.

A decay of ornamental cactus: A large planting of ornamental cactus, *Echinocereus chloranthus*, in South Texas was destroyed by a disease found to kill over 90 per cent of the plants. Affected pads took on a watersoaked, greenish appearance and were covered by a thick greenish layer of spores identified as *Helminthosporium* sp. Inoculations were made with this organism and the disease successfully reproduced in normal pads. The identity of this fungus remains to be determined. J. J. Taubenhaus.

Verticillium wilt of dahlias: In a planting of dahlias near Lubbock, Texas, some were found in a wilting and dying condition. Cultures were made of portions of the infected stems and roots, and a pure culture of

Verticillium was recovered from the infected plants. The fungus was identified as *Verticillium albo-atrum*, an organism capable of attacking a large number of hosts.

J. J. Taubenhaus, D. L. Jones.

Gourd seed, carriers of *Sclerotium bataticola*: Seeds were secured from gourds affected by "charcoal rot," *Sclerotium rolfsii*, which were stored in an open shed at College Station. The seeds showed considerable evidence of exterior and interior discoloration. Of a total of 153 gourd seed cultured, *Sclerotium bataticola* was recovered from the interior of 19 per cent of these seed.

J. J. Taubenhaus.

Smut on horned rush: In the 1934 report, a smut (*Testicularia cypari*) was reported to attack horned rush (*Rhynchospora corniculata* Lam. Gray var. *interior* Fernald). Horned rush is considered a valuable hay crop in many fallowed rice fields. Fear was expressed of the possibility of this smut being harmful to livestock. However, no cases of stock poisoning were found from stock feeding on the infected plants whether used as green or cured hay. During 1936, the *Testicularia* smut was found in its usual abundance in fallow rice fields in the vicinity of Bay City, Texas. Attempts to germinate the spores of the smut fungus have thus far failed.

J. J. Taubenhaus.

A disease of buffalo grass seed: During 1936, buffalo grass, *Buchloe dactyloides*, seed were affected by a spotting determined to be caused by a fungus, *Cercospora seminalis*. This trouble is frequently mistaken for smut or ergot and appears to be seed-borne. In view of the importance of this grass in soil conservation, control work needs to be done through seed treatments.

J. J. Taubenhaus.

Lumber decay: There have been numerous inquiries during 1936 of a decay of lumber in frame houses in different parts of the State. The trouble was found to be caused by several fungi, the most common of which were *Poria incrassata*, *Merulius lachrymans*, and *Merulius americanus*.

J. J. Taubenhaus.

Angular leaf spot on different varieties of cotton: This report is included under Substation No. 5.

Miscellaneous diseases: This report is included under Substation No. 5.

Diseases not previously reported from Texas*

Allium cepa, leaf spot, *Aspergillus eurotium nidulans*.
Allium sativum, leaf spot, *Myrothecium roridum*.
Ampelopsis aconitifolia, leaf spot, *Tubercularia nigricans*.
Bambusa sp., leaf spot, *Coniosporium shiraiandum*.
Bignonia radicans, leaf spot, *Myrothecium roridum*.
Celtis sp., root rot, *Armillaria mellea*.

* Fungi identified by J. A. Stevenson, J. H. Martin, Misses Edith Cash, and Vera K. Charles.

Citrus sinensis, fruit rot, *Fusarium limonis*.
Cucurbita sp., stem rot, *Phoma subveluta*.
Fraxinus pennsylvanica, leaf spot, *Phyllosticta viridis*.
Hicoria pecan, various diseases, *Mycosphaerella dendroides*, *Mycosphaerella caryigena*, *Cercospora caryigena*.
Hymenoclea monogyra, various diseases, *Phoma herbarum*, *Macrosporium puccinioides*, *Puccinia splendens*.
Ilex decidua, leaf spot, *Rhytisma ilicinola*.
Ipomoea batatas, stem rot, *Nectria ipomoeae*.
Lathyrus odoratus, leaf mold, *Cladosporium album*.
Lycopersicum esculentum, fruit rot, *Chaetomium bostrychodes*.
Magnolia grandiflora, various diseases, *Heterosporium magnoliae*, *Pestalozzia guelpini*, *Cephaleuros virescens*, *Exophoma magnoliae*.
Mathiola incana, leaf spot, *Myrothecium roridum*.
Morus nigra, leaf spot, *Phleospora maculans*.
Narcissus jonquilla, leaf spot, *Hendersonia curtisii*.
Panicum capillarioides, leaf spot, *Stagonospora curvula*.
Sorghum vulgare, leaf spot, *Phyllosticta sorghina*, also attacks Johnson grass.
Sorghum vulgare, seedling blight, *Colletotrichum graminicolum*.
Sporobolus, leaf spot, *Helminthosporium ravenelii*.
Vernonia fasciculata, rust, *Coleosporium carneum*.

Fig mosaic: Virus disease found in fig orchards in Galveston county.

Rice dwarf: Virus disease found in a single rice field near Beaumont. The same disease also attacks *Echinochloa crusgalli*.

Yellow dwarf of onion: A virus disease was found in scattered onion fields in Zapata county. A similar disease was also found on *Allium ascalonicum*, *Allium canadense*, and *Allium vineale* in the vicinity of Laredo, Texas.

Plant disease survey

This work is carried on in cooperation with the U. S. Plant Disease Survey. Complete records were kept during 1936 of the prevalence of plant diseases of economic crops and of weeds. A bulletin is now in preparation of the various diseases of Texas crops and weeds, and methods of control.

J. J. Taubenhaus.

SOIL SURVEY

(In cooperation with the Bureau of Chemistry and Soils,
 U. S. Department of Agriculture)

Soil survey work was carried on continuously throughout the year. This work consisted chiefly of regular field surveys conducted over several counties. Mapping of the soils on detailed scale was done by

the field men of the Texas Station working in cooperation with field men of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture.

The survey of Kaufman County was completed in May and that of Maverick County in June 1936. These areas were started prior to the beginning of the fiscal year. The field surveys and reports are being prepared for publication. Field work was resumed in Brown and Fannin counties, these areas having been discontinued early in 1935 because of the necessity of removing some of the Federal soil surveyors temporarily from the State. Field work was started in Dimmit County just about the end of the fiscal year. Approximately 840,000 acres were surveyed in Texas during the year.

Soil classification and correlation continue to be held to the same standards employed in all cooperative work throughout the United States. Due to increasing detail required in the work, considerably more time is now necessary to cover a county by the detailed soil survey. The large amount of information required in studies relating to land use and soil conservation demand more complete information by the Soil Survey. Efforts are now being made to devise a system of land and soil ratings which will enable a rapid evaluation of the lands in a county and also be suitable for soil and land ratings on a national basis.

Inspections were made of the soil survey field work at intervals to insure uniformity and accuracy. This was done by supervision not only by State service but by Federal workers concerned with the special duties of soil correlation made to conform to national unity of soil nomenclature.

Some inspection service for purposes of soil correlation was provided for a few conservation surveys made by the Soil Conservation Service.

Soil Survey of Kaufman County

Kaufman County lies in northeastern Texas largely within the Blackland Prairies, though the eastern part is occupied in places by parts of the East Texas Timber Country wherein the soils are light-colored and sandy. The county is thickly settled, and a very large proportion of the land is cultivated. The chief crops are general farm crops, such as cotton, corn, small grains, and various feed crops.

Nearly 50 different soils were found in the county during the survey, and most of these are of types and phases that are well known. Final correlations and official designations of the soils have not been made as yet. Most of the soils of the Blackland Prairies appear to be quite productive and well suited to the crops grown. The sandy light-colored timbered soils are of moderate productiveness, though susceptible

to improvements and fertilization. These are well suited to various truck crops, fruits, berries, and grapes. Some of the soils, however, have such limitations in drainage, caused by flat surfaces and dense clay subsoils, that the soils are much lower in productive value than other closely associated soils having friable subsoils and adequate natural drainage. The soil map will enable the direct application of practices relating to cropping and soil use and preservation as have been determined to be necessary by experimental research on the various substations of the Experiment Station system.

E. H. Templin, J. W. Huckabee, Jr., W. T. Carter.

Soil Survey of Maverick County

Field work was completed in Maverick County, and about 35 different soils were found and their areas shown on the soil map, thereby indicating the location and extent of each soil in the county. Considerable settlement has taken place in the Quemado Valley, a section of the Rio Grande alluvial bottomlands, since the survey was started.

Due to low rainfall, systematic production of farm crops is not possible in this county without irrigation. Many smooth valley areas along the Rio Grande and creeks, as well as on high uplands, are occupied by valuable productive soils that are suitable for use under irrigation. Some, however, lie far from a present available source of water supply and may not be used for farming for a long time, or until such time as water may be provided. Other considerable areas lie well situated for use under the system that is being developed below the Quemado Valley area of irrigation canals.

Many soils that are suitable for a large number of general farm crops and truck crops have been mapped and will be described in the report. From this survey and information gathered from various other sources it appears that large areas of the county, even of deep smooth soils, will long be continued in use for the grazing of range livestock.

H. M. Smith, I. C. Mowery, W. T. Carter.

Soil Survey of Fannin County

Fannin County is a large, highly cultivated area of northeastern Texas bordering Red River. The largest part of the county lies in the Blackland Prairies, and a number of soils of the Houston, Wilson, and Crockett series are being located and mapped. A considerable number of bottomland soils of the Miller and Yahola series are being indicated in Red River Valley, and of Trinity, Catalpa, and other series in some other stream valleys.

During the progress of the survey some basic information of the soils is being given to Resettlement Administration workers in connection

with the development of projects in land use and land resettlement which that organization is carrying on.

E. H. Templin, I. C. Mowery, W. T. Carter.

Soil Survey of Brown County

During the year some work was done in continuing the soil survey of Brown County. This survey is indicating the presence of many different kinds of soils in a region where the development of varied soil characteristics has been brought about by the several kinds of geological formations outcropping in many small intermingled areas, by the varied timber and grass vegetation, and by the extreme variations in soil moisture where the humid and subhumid climatic zones merge.

The survey is also indicating the presence of a large amount of highly productive alluvial valley soils that are well suited to irrigation from the recently completed reservoir on Pecan Bayou near Brownwood.

W. I. Watkins, T. W. Glassey, W. T. Carter.

Soil Survey of Dimmit County

Due to a strong request of the citizens of Dimmit County, a soil survey was started during the last days of the fiscal year. This area is in the undulating Rio Grande upland plain where irrigation is required for most crops. Because of the equable mild climate and source of underground and river water in many sections, a considerable industry in farming and truck crop growing has been established.

In some sections irrigation water cannot be secured and, doubtless, in such places the soils, even though well suited to many crops, will remain in grazing areas for range livestock.

This county is in the Winter Garden district and a considerable acreage of citrus fruits has been growing successfully for several years. The subexperiment station located a few years ago at Winterhaven in the northern part of Dimmit County has established the values and limitations of a number of truck and fruit crops and has developed certain valuable practices. The results will be readily interpreted through the soil survey to the agricultural interests on many of the soils throughout Dimmit and various other counties of the general Winter Garden area.

H. M. Smith, J. W. Huckabee, Jr., W. T. Carter.

Miscellaneous

During the year the Division cooperated with some other agencies and organizations in aiding in giving information relating to soils of the State. Some trips were made by the Chief of the Division with various members of the Soil Conservation Service in studying and

correlating soils and soil conditions in projects of that Service on the Grand Prairies near Waco, the Blackland Prairies near Marlin, and in the northern part of the Panhandle region. This was in addition to the regular inspection of the soil survey field work by the Chief of the Division, who performed this service as Inspector of District 4 of the Bureau of Chemistry and Soils.

Some information was given on soils by correspondence from headquarters at the Experiment Station. Inquiring landowners and farmers desiring information on soils were advised by correspondence.

W. T. Carter.

Several typical profile monoliths were collected and prepared in the field to be placed on display as exhibits in the Federal Building on the Texas Centennial Exposition grounds at Dallas and with the West Texas Chamber of Commerce at Fort Worth.

E. H. Templin, J. W. Huckabee, Jr.

Many large and small soil samples were collected in Kaufman and Maverick counties and forwarded to the Division of Chemistry of the Experiment Station at College Station for the purpose of providing materials for the continued investigations being made by that Division on the fertility of the soils of Texas.

H. M. Smith, E. H. Templin, J. W. Huckabee, Jr., Irvin C. Mowery.

During the year cooperative soil survey reports published and issued by the U. S. Department of Agriculture include soil surveys of Hardeman, Falls, and Scurry counties. One technical paper entitled "Plant Species Adapted to the Southern Prairies and Great Plains" was prepared and published in the proceedings of the American Soil Survey Association.

W. T. Carter.

FARM AND RANCH ECONOMICS

Organization and Management of Farms in the High Plains Cotton Area of Texas

(In cooperation with the Bureau of Agricultural Economics,
U. S. Department of Agriculture.)

This project was designed to provide a body of basic farm management data for the use of farmers, farm leaders, research workers, and extension workers in dealing with the farm problems of the area.

Records of the details of organization and operation have been obtained covering 127 to 141 farms for a period of 5 years, 1931 to 1935. The major part of the field work was completed during the year. Preliminary reports have been issued for each of the five years showing the financial results obtained and featuring certain problems of farm organization and operation, such as costs of farm power, changes in types of power and size of machinery, feed requirements of livestock and feed reserves,

and the consumption of farm-raised products in the home. The data obtained are being interpreted for final publication during the coming year.

A summary of the averages of some of the more significant data pertaining to organization and operation of these farms and to the financial results obtained during each of the five years is given in the following table.

	1931	1932	1933	1934	1935
Number of farms.....	141	138	127	139	138
Average size.....Acres	290	288	271	263	268
Crop land.....Acres	237	241	218	235	222
Per cent land in crops.....	81.8	83.5	80.4	89.5	82.8
Acres planted in cotton.....	103.8	107.0	116.0	63.0	71.7
Per cent crop land in cotton.....	43.8	44.4	53.2	26.8	32.3
Average yields:					
Cotton lint.....Pounds	245	226	233	39	177
Milo.....Pounds grain	1,792	1,532	1,245	204	1,090
Cane.....Pounds forage	3,734	4,380	2,650	507	3,712
Yield index.....	137	124	113	26	100
Average price received for cotton.....cents	5.1	5.3	9.0	10.9	10.1
Average inventory (excluding value of residence).....Dollars	10,586	10,249	10,177	10,150	10,027
Cash Sales—Total.....Dollars	2,175	1,973	2,790	2,160	3,269
Per cent of sales from:					
Cotton lint and seed.....	66.9	67.7	45.4	8.3	46.7
Cotton adjustment benefit payments and sale of Headhead certificates.....			22.6	38.0	23.5
Total cash expense.....Dollars	1,241	1,167	1,413	1,172	1,630
Net cash income.....Dollars	934	806	1,377	988	1,639
Operator's labor and management earnings.....Dollars	223	124	1,808	254	980
Rate earned on average inventory.....Per cent	5.86	5.22	21.56	6.81	13.25

In the last report, attention was called to some significant changes taking place in the area in the use of farm equipment. These changes continued at a rapid rate during the past year, as is brought out in the following table.

Changes in size of equipment used on farms studied March 1, 1931, to March 1, 1936, and acreage of crop land on farms using each size of equipment in 1935

Item	Year						Crop land per farm during 1935 (Acres)
	1931	1932	1933	1934	1935	1936	
Total number of farms.....	141	138	127	139	139	138	
Farms using 1-row horse-drawn equipment..	10	7	5	5	5	7	98
Farms using 1-row and 2-row horse-drawn equipment.....	71	64	47	32	23	16	182
Farms using 2-row horse-drawn equipment	24	37	49	68	47	43	207
Farms using 2-row tractor-drawn equipment	36	30	26	30	54	63	243
Farms using 3-row and 4-row tractor-drawn equipment.....	0	0	0	4	8	9	396
Per cent of farms using only 2-row or larger equipment.....	42.5	48.5	59.0	73.4	78.4	83.3	
Per cent of farms having tractors.....	25.5	21.7	20.5	24.5	44.6	52.1	

Accompanying these changes in the size of equipment used were changes in the size of farms. According to the 1935 Federal Census, the average acreage per farm had increased from 232 acres to 267 acres, or 15 per cent, since 1930, in the five counties in which these studies are being made. During the same period of time, the acreage planted to crops increased 13 per cent per farm, or from an average of 147 acres to 166 acres. These changes in size of farms were accompanied by an increase of less than one-half of one per cent in the number of farms, or a total increase of only 45 farms in the five counties.

C. A. Bonnen, B. H. Thibodeaux, Bur. Agr. Econ., and A. C. Magee.

Range Management in the Edwards Plateau Grazing Area

(In Cooperation with the Texas Extension Service and the Bureau of Animal Industry, U. S. Department of Agriculture.)

Studies have been conducted on 30 to 40 ranches during the period 1931 through 1935 to determine and measure insofar as possible the significance of those factors which result in large crops of young, heavy fleece weights, and small death losses. Variations in these three factors were found to explain 48 per cent of the variation in ranch incomes during the period 1924 through 1928. The field work has been completed and the data are being prepared for publication.

A preliminary analysis indicates that much of the variation in both the size of the lamb crop and in the weight of fleece is due to variations in the type of range, in rates of stocking, and in the age of ewes.

C. A. Bonnen and W. R. Nisbet.

Regional Agricultural Adjustment

(In Cooperation with the Agricultural Adjustment Administration and the Bureau of Agricultural Economics, U. S. Department of Agriculture.)

Practically all divisions of the Station, including the Substations, are cooperating in certain phases of this project. The main objective is the development of information, by type-of-farming areas, to facilitate the planning of adjustments in the agriculture of each area. Three different lines of work were followed during the year.

1. The data pertaining to types of farming were brought up to date and the analysis of these data permitted a refinement of the delineation of type-of-farming areas and a fuller description of the agriculture of the State as a whole and of each area. This material is ready for publication as a revision of Bulletin No. 427, "Type of Farming Areas in Texas."

2. Detailed studies of the organization and operation of farms, with special attention to soil and moisture conservation problems and practices, were made in two areas, the Black Prairie and the Low Rolling Plains.

In the Black Prairie the work was done in the Elm Creek Watershed in Bell, Falls, and Milam Counties on farms which had previously been mapped by the Soil Conservation Service. These maps show soil types, slopes, degree of erosion, and vegetative cover or crops. Previous work also included an economic survey of 300 farms, which was made during the fall of 1934. A preliminary report is being prepared giving some of the results of an analysis of these data. Present work in this area includes cooperation with 125 to 150 farmers in keeping detailed records of the results of their farming operations to serve as a basis for evaluating various soil and water conservation practices and to provide other data necessary to the planning of adjustments in farming systems.

The work in the Low Rolling Plains was carried on in Jones County, which was selected as typical of the farming section of that area. Through the use of AAA worksheets and with the assistance of the county agent and the committee in charge of the agricultural adjustment program in the county, 200 farms were selected as typifying the common sizes and types of farms in the area. These farms were mapped by representatives of the Soil Conservation Service, showing soil types, slopes, erosion condition, and vegetative cover. Data were obtained from the operators of the farms as to organization, expenses and receipts, crop and livestock practices, soil and moisture conservation practices, and as to the relation between production, soil and moisture conservation practices and the different conditions of soil, slope, and erosion condition. These data are being prepared for analysis at the present time.

3. Clerical help was given to various divisions of the Experiment Station in order to permit them to analyze certain technical data by type-of-farming areas and to prepare them for use in planning adjustments in agriculture. This work is in various stages of completion and will be continued as funds are available.

In addition to the above lines of work, cooperative relations were maintained with research groups in adjoining states and in the federal government for the purpose of coordinating the results of such projects into a concerted national program of research in this field.

C. A. Bonnen, B. H. Thibodeaux, Bur. Agr. Econ., and A. C. Magee.

Quality as a Factor in the Marketing of Vegetables in the Lower Rio Grande Valley of Texas

According to present procedure in shipping point inspection, the service is available to the shipper in the carload unit, straight or mixed. The service is not available directly to the grower unless he loads in carload lots. Thus such benefits as may accrue to growers of shipping point inspection are derived indirectly through benefits to shippers.

With vegetables, sorting and grading begin with the harvesting process in that only vegetables of quality suitable for marketing are

harvested rather than all the crop. The skill of the harvesting crew and the exactness of the supervision of their operations are factors of importance in a consideration of quality.

According to the results ascertained in this study, premiums paid growers for cabbage, carrots, and beets loaded in carloads grading U. S. No. 1 are very slight, if any, over prices paid growers for these vegetables loaded in carloads failing to grade U. S. No. 1.

As for potatoes and tomatoes, however, quality is a real factor in determining prices received by growers. At the season potatoes are shipped to the markets from the Lower Rio Grande Valley, this product is in the nature of a specialty. High quality is essential in order to create a preference over the old potatoes still on the market. The premiums on high quality are reflected in prices paid shippers who in turn pass on these premiums to growers.

The Texas tomato is shipped green. Great care is essential in selecting stock that is smooth and free from excessive scars in order to assure a product that will have a pleasing appearance on ripening. Thus clear and smooth tomatoes of uniform size are in demand. Furthermore, the better quality reduces waste to the retailer. This is one reason that the retailer is willing to pay a premium for the better quality.

A manuscript is now in preparation covering this project.

W. E. Paulson.

Central and Local Market Prices of Wheat in Relation to Quality

(In Cooperation with the School of Agriculture, A. & M. College of Texas, and the Division of Chemistry)

At a given local market, under the prevailing marketing system in the Panhandle area of Texas, variations in protein content of wheat are not reflected in prices paid growers. For instance, on a given day, samples taken from 25 truckloads sold at the same elevator varied in protein content from 14.14 to 20.87 per cent. Prices paid growers differed by 8c a bushel but this was due entirely to variations in test weights which ranged from 52 to 60 pounds a bushel. At this time, the protein premium paid on the Fort Worth market was $\frac{1}{2}$ ¢ per $\frac{1}{2}$ point above 13 per cent. Such recognition as is given protein content in prices paid growers at a local point is reflected in terms of the average protein content of the area.

Grade is a price factor in the local markets of the Panhandle area. During the seasons 1932, 1933, and 1934, discounts of 1c a bushel per pound under 60 pound basis prevailed. Of the samples secured, 6, 22, and 63 per cent scored No. 1 for the seasons 1932, 1933, and 1934, respectively. Smut was found in 24, 26, and 10 per cent of the samples

for the years 1932, 1933, and 1934, respectively. Discounts in force for smut were: 1c a bushel for light; 3c for medium; and 5c for heavy.

W. E. Paulson, G. S. Fraps, and R. T. Stewart.

Operating Costs and Financial Conditions of Gins in Texas

(In Cooperation with the Cooperative Division, Farm Credit Administration.)

During the year, data and information were secured on the operations of 103 cooperative gins for the season 1934-1935 and of 152 cooperative gins for the season 1935-1936. The schedules are now in the process of being edited.

Of the 152 cooperative gins active during the season 1935-1936, 26 were organized in 1934 and 49 in 1935. Thus of the total number of active cooperative gins, 17.1 per cent began operations in 1934, and 32.2 per cent in 1935, or 49.3 per cent during the two-year period.

A preliminary mimeographed report, primarily for distribution to the cooperative gins of Texas, was issued in December, 1935. This report deals with the operations of 72 cooperative gins for the season 1933-1934. On an average, patrons of these gins paid a charge of \$6.37 a bale, \$5.34 for ginning toll and \$1.03 for bagging and ties. On the assumption that the rates of the cooperative gins were determined by competition, the \$6.37 was the average charge of ginning per bale of growers patronizing the gins competing with the cooperative gins. Since the average cost of ginning per bale of the cooperative gins was \$3.99, a net profit of \$2.38 per bale was realized. This profit was equal to 37.4 per cent of the ginning charge. The total profit on the 264,000 bales ginned by the 72 cooperative gins was \$628,000, or about \$50 per member of the total membership of 12,726. A total cash dividend of \$414,000 was paid, or an average of nearly \$33 per member.

Information on the early financial history was obtained on 130 of the 152 gin associations. On an average, for the 130 gins, cash payments by members at the time of organization amounted to only 10.5 per cent of the total cost of the gin plants. In the case of nearly one-half of these gins, no cash was paid in by members at the time of organization. Members joining cooperative gins in Texas, in most instances, expect to provide a large part of the necessary capital out of profits of operation. Under this plan of financing, members provide capital out of profits due to patronage. This raises the question of members' equities in the gin associations. In some instances, the By-Laws specify that property rights of members are equal. Since cooperative gins, without exception, follow the patronage principle in distributing cash dividends to members, it would seem that the same principle should obtain in regard to the equities of members in the gin plant insofar as the investment is paid for out of profits.

In distributing profits by cooperative gins to their members, the particular share to each member is determined according to a number of different bases. The running bale is quite popular. But the running bale may be a rather inaccurate measure of patronage contributions to profits. Experience has shown a tendency on the part of some members to reduce the size of their bales in order to increase the number of bales. This practice has been forestalled, in some instances, by shifting from the running bale to the 500-pound lint bale as the basis for computing the patronage dividend. A very large percentage of the cooperative gins exact ginning tolls according to the weight of seed cotton ginned. Accordingly, an increasing number of gins use the cwt. of seed cotton ginned, rather than the running or lint bale as the basis of dividend distribution. Cotton seed left with the gin is an important source of profit. The amount of seed per bale left with the gin varies considerably as between the different members. An increasing number of cooperative gins are segregating seed profits from other profits and are distributing these profits according to the amount of seed left with the gin by the different members. Several gin associations have gone so far as to charge losses on cotton bought from members against the bales bought. This is as much as saying to the member that he has already received a patronage dividend to the extent that the price paid him was over the market.

L. P. Gabbard and W. E. Paulson.

Trend of Taxes on Farm and Ranch Real Estate in Texas

Through a W. P. A. project it has been possible to expand and supplement the data published in Station Bulletin No. 512, "Trend of Taxes on Farm and Ranch Real Estate in Texas." This bulletin showed the taxes per acre on farm and ranch lands in 160 selected counties in the State for the period 1913 to 1933, inclusive. Through cooperation with the Works Progress Administration, similar data have been secured in 58 selected counties for the period 1913 to 1890, inclusive, and the two recent years, 1934 and 1935. These data are being summarized and, it is hoped, will be published during the coming year in mimeograph form as a supplement to Bulletin No. 512.

Costs and Services of Local Government in Texas

As stated in the forty-eighth annual station report, the primary purpose of this study is to analyze the financing of the various services provided by typical rural counties with respect to number, cost, and methods. The possibilities of reducing farm taxation through lowering the actual costs of specific services or through providing more efficient services without a reduction in costs will be studied. As one important phase of the problem, the adequacy of existing services as compared

to the needs of the rural population will also be examined. The tabulation and summarization of the data secured in this study have been completed and prepared in manuscript form during the year and should be published in bulletin form some time during the coming year. The following illustrate some of the more significant findings and conclusions resulting from this study:

I. Government, in Texas, is administered through more than 8,300 units, each of which has its own governing board, collects its own taxes, and renders one or more services. These units include the State itself, 254 counties, 580 cities and villages, 7,200 school districts, and 271 water and other districts. The counties and the schools are the units of concern in this study.

II. The analysis of county expenditures reveals three important points: (1) Many of the smaller counties have insufficient resources to maintain adequate services without increasing costs tremendously as compared to the larger counties; (2) the plan of organization should be improved in all counties, regardless of size; and (3) the state should take an increased interest in and responsibility for the work performed in the counties. Such work includes budgeting, accounting and auditing, assessing and collecting taxes, creating and administering indebtedness, selecting officers and employees, and enforcing laws.

III. The savings from consolidation are largest in the counties having fewer than 5,000 people, and they gradually decrease as the population increases. Apparently these savings become insignificant after a population of 35,000 to 40,000 is reached. Using the costs of the county having a population of 20,000 as a standard, it is estimated that consolidation would save \$2.91 per capita in the counties having fewer than 5,000 people. This amount is equal to 21 per cent of the total cost of county government, 25 per cent of the operating costs, and 63 per cent of the costs affected by consolidation.

The adoption of the county manager or county executive plan should provide substantial savings. In the county of 20,000 population it is estimated that \$10,000 to \$15,000 per year might be saved in salaries. In addition, the savings in purchasing equipment and supplies, and in operating all services should approach the savings in salaries, in many instances. A third and slightly different type of saving arises from the increased efficiency of all services rendered. This would not be a saving in the sense of reducing taxes, but it would be a saving in the sense of providing more for the money.

L. P. Gabbard and H. C. Bradshaw.

Farm Leasing Systems in Texas

The chief purpose of this project is to discover the leasing systems best adapted to the various types of farming in Texas. A good leasing

system is one that, among other things, (1) provides for a fair and equitable distribution of farm income between landlords and tenants; (2) encourages the maintenance and improvement of farm land and buildings; (3) permits and encourages security and length of tenure; and (4) makes possible a decent and wholesome standard of living, and promotes a strong, cooperative community life.

In 1935, the Bureau of the Census of the United States Department of Commerce found that 39 per cent of the share tenants and 48 per cent of the croppers had been on their farms for less than one year. Certainly these figures indicate that our present leasing system does not encourage "length and security of tenure," prerequisites to good farming, soil conservation and improvement, and to high standards of living.

Preliminary investigation reveals, however, that in some communities farm tenants are relatively stable. Investigations now under way will determine the extent to which the farm lease contract (or informal agreement) is functionally related to length of tenure. Other factors related to length of tenure will be studied.

Since this project had been under way only two months at the time of this report, no extensive results are yet available. Work now being carried on includes (1) analysis of several hundred farm management records to determine the distribution of expenses and incomes between landlords and tenants; (2) field survey of 450 farms in three type-of-farming areas to determine types of characteristics of leasing agreements; (3) collection of lease forms for different types of farms and farm leasing; and (4) interviews and discussions with representative groups of landlords and tenants to determine ways and means of improving existing leasing systems.

Contacts made with farm groups thus far indicate a widespread desire on the part of land owners to work out improved farm-leasing agreements. It is planned to encourage land owners to experiment with leasing agreements which may help to eliminate some of the worst evils of the tenant system.

L. P. Gabbard and C. H. Hamilton.

Cooperation with the Division of Social Research of the Works Progress Administration

Since October 1934, this Division has supervised surveys having to do with the current relief situation in Texas under a cooperative agreement between the Texas Agricultural Experiment Station and the Works Progress Administration. Two major studies have been conducted during the year just ended, DRS-109-109-A covering 28 selected sample counties in Texas and DRS-160-162 covering 28 selected counties

throughout the State. DRS-109-109-A was conducted to obtain information relative to that part of our population participating in the rural relief and rural rehabilitation programs. Under DRS-160-162, relief data including the welfare activities of both public and private agencies have been secured monthly and made available to the Federal Works Progress Administration since April 1, 1936.

During the year, manuscripts and reports have been prepared on 28 selected counties under the composite title, "Current Changes in the Rural Relief Population" (June, 1935). These reports are on file at College Station and in the Washington office. Three statistical bulletins (mimeographed) have been published under the following titles:

1. "Texas Unemployable Cases in Rural and Town Relief Population" (January, 1936).
2. "Education of Heads and Children in the Texas Rural and Town Relief Population" (June, 1936).
3. "The Farm Operator in the Texas Rural and Town Relief Population" (October, 1935).

L. P. Gabbard and C. E. Ullrich.

BOTANY

The work of this division is concerned with the identity and distribution of native vegetation. The presence of vegetation as feed for livestock or as plants harmful to livestock, or for their value as honey producers, as well as the presence of plants that act as carriers of plant diseases, have an important relation to agriculture.

The study of native vegetation in relation to the livestock industry is centered around the work of the Ranch Experiment Station located near Sonora. Two phases of this study are being considered: the occurrence of species furnishing vegetation, and the occurrence of species that are harmful to livestock or have low range feed values. A detailed study of the vegetation on a number of different ranges has been made to determine the species present and their period of growth and fruiting, and to obtain some information as to the extent to which they contribute to the range feed supplies. Such work is also a means of quickly evaluating the range vegetation at any given period of time when harmful species are suspected of poisoning livestock.

The work in connection with honey plants has been centered at the Apicultural Research Laboratory near San Antonio, and is reported under the Division of Apiculture.

The study of native vegetation as a carrier of plant diseases is centered at Substation No. 5, Temple, principally in connection with a

study of cotton root rot disease. Some additional work in connection with plants as weed pests has been carried on at the Winter Garden Station and at the Apicultural Research Laboratory.

V. L. Cory.

SWINE HUSBANDRY

Utility of Rice and Rice By-Products for Growing and Fattening Pigs

The principal object of this study is to determine the effect of varying amounts of rice hulls in fattening pig rations. Two 90-day tests were conducted this year. In the summer test, the three rations used contained ten, fifteen, and twenty-five per cent of finely ground rice hulls, respectively. These rations were compared to a check ration which contained no rice hulls. The pigs getting the check ration (without rice hulls) gained an average of 1.43 pounds per day, and required 408 pounds of feed per 100 pounds of gain. Pigs fed the ration containing 10 per cent of rice hulls made an average daily gain of 1.33 pounds and required 433 pounds of feed per 100 pounds of gain. The pigs getting the ration containing 15 per cent of rice hulls had an average daily gain of 1.30 pounds and required 450 pounds of feed per 100 pounds of gain. Pigs receiving the ration containing 25 per cent of rice hulls made an average daily gain of 1.25 pounds per day and required 494 pounds of feed per 100 pounds of gain.

In the winter test, the check ration (containing no rice hulls) was compared to a ration containing 25 per cent of rice hulls. The pigs getting the check ration made an average daily gain of 1.80 pounds and required 377 pounds of feed per 100 pounds of gain, while the pigs getting the ration containing 25 per cent of rice hulls made an average daily gain of 1.46 pounds and required 458 pounds of feed per 100 pounds of gain.

The check ration was composed of 86 pounds ground yellow corn, 6 pounds of 60 per cent protein tankage, 6 pounds of 43 per cent protein cottonseed meal, 1 pound of oyster shell flour, and 1 pound of common salt. In the rice hull rations, the corn in the ration was reduced according to the amount of rice hulls added. The pigs in these tests were fed individually by pairs.

The rice hulls apparently had no irritating effect on the digestive tract according to the appearance of the viscera at the time of slaughter. The average daily gains, however, were reduced as much as 18 per cent and the feed requirements per 100 pounds of gain were 21 per cent greater when the ration contained 25 per cent of rice hulls. All of the rations containing rice hulls gave smaller daily gains and larger feed requirements per 100 pounds gain.

F. Hale.

Self-Feeding Brood Sows

This study relates to methods of feeding brood sows as to the effect on the general health and condition of the sows during both the gestation and lactation periods, the growth of the litter, and the saving of labor.

The work to date shows self-feeding an expensive method except during the lactation period. Feeding the sows either two or three times per week does not permit the feeder to see the sows often enough to check over their condition. Feeding once a day has given as good results as the general practice of feeding twice per day. In hot weather the sows are fed in the morning, as this saves them from getting hot at the evening feeding time. The sows are given the day's ration in one feed. This saves half the labor required for feeding and also gives one an opportunity to check the sow's appetite daily.

In the winter, the sows are fed in the afternoon, as this time seems to fit in better with the day's work when pipes are likely to be frozen in the morning. This leaves more time to give the necessary attention to jobs on a cold morning other than feeding.

The sows adjust themselves to once-a-day feeding after about ten days and once they are adjusted to the new schedule, they never show any discontent.

F. Hale.

Quantitative Requirements of Vitamin A for Pigs

This project is to study quantitatively the requirements for pigs of vitamin A as to gain, economy of gain, and the quantity of vitamin A needed by brood sows to produce uniform pigs of high vitality.

Female pigs farrowed by sows in September of this year will be selected with which to begin this study. These pigs at about four months of age will be placed on rations containing known quantities of carotene.

F. Hale, G. S. Fraps.

Calcium Requirements of Growing and Fattening Pigs When Fed Grain Rations Balanced with Cottonseed Meal

The calcium was supplied in the rations used in these tests in the form of oyster shell flour containing 54.57 per cent lime (CaO). Pigs getting the ration containing no oyster shell flour gained only 1.03 pounds per day during the 90-day test and required 440 pounds of feed per 100 pounds of gain. They were also showing signs of rickets at the end of the test. The pigs getting one per cent of oyster shell flour in their ration made an average daily gain of 1.25 pounds and required 405 pounds of feed per 100 pounds gain, while the pigs getting

two per cent of oyster shell flour in their ration gained 1.24 pounds per pig per day and required 417 pounds of feed per 100 pounds of gain. No signs of rickets showed up among the pigs getting rations containing one per cent or two per cent oyster shell flour. These tests indicate that no advantage is gained by adding as much as two per cent of oyster shell in a ration of yellow corn, cottonseed meal, and salt. The average initial weight of the pigs used in these tests was 69 pounds.

F. Hale.

Value of Sudan Grass and Oats Pasture for Fattening Hogs

One 90-day test was made with sudan grass and one with oats pasture this year. Ten pairs of pigs were used in each test and were fed individually. The pig on pasture had access to an individual pasture lot, so that both pigs in each pair were fed individually as to both concentrates and pasture. With sudan grass, the pigs made an average daily gain of 1.6 pounds as compared to 1.53 pounds for the dry-lot fed pigs. The pigs in dry lot required 322 pounds of kafir and 35 pounds each of tankage and cottonseed meal per 100 pounds of gain. The pigs getting sudan required 331 pounds of kafir and 27 pounds each of tankage and cottonseed meal per 100 pounds gain. With a price equivalent of three pounds of grain to one pound of tankage, the pigs on sudan grass ate five pounds of tankage and eight pounds of corn less per 100 pounds of gain. Since the gain for the ten pigs was 2100 pounds per acre, the total feed saved was 105 pounds of tankage and 168 pounds of cottonseed meal per acre of sudan grass for the 90-day period.

The oats-pasture test was conducted through December, January, and February. The pigs on oats pasture gained 1.82 pounds, while the pigs in dry lot gained 1.67 pounds per pig daily. The dry lot fed pigs required 349 pounds of grain, 32 pounds of tankage, and 32 pounds of cottonseed meal per 100 pounds gain, while the pigs getting oats pasture required 349 pounds of grain, 14 pounds of tankage, and 14 pounds of cottonseed meal per 100 pounds of gain. The pigs getting oats pasture gained 2464 pounds per acre; therefore an acre of oats pasture saved 345 pounds each of tankage and cottonseed meal for the 90-day period. Although the oats pasture proved better for fattening hogs than sudan, the sudan grass is grazed in the summer when oats pasture would not be available.

F. Hale.

The Effect of Maternal Vitamin A Deficiency Upon Development of Tissues and Development and Position of Organs in Animal Embryos

The first results of this study were reported in the 1932 annual report of the Texas Station, page 91. Since then, 59 pigs have been produced experimentally by feeding gilts a ration deficient in vitamin A for a

period sufficient in length to practically deplete the body of vitamin A before and for the first thirty days after they were bred. In June and July of this year, one litter of eight and one litter of nine blind pigs were produced with conditions similar to those under which the 42 blind pigs previously were produced.

In the June litter, there were five females and four males. The females were all blind (showed bilateral microphthalmia), one female showed kidneys with double ureters and both kidneys were in the pelvic cavity at birth. Another female showed a misplaced left ovary. The four male pigs in the litter were all blind (bilateral microphthalmia), two were bilateral cryptorchids, and two were unilateral cryptorchids. The right kidney of one of the male pigs was found to be in the pelvic region.

In the July litter, there were five females and three male pigs. The three males were blind at birth (bilateral microphthalmia). One of the males had a cleft palate and a double harelip and another male had a partial cleft palate at birth. The three males were bilateral cryptorchids and their kidneys were in the pelvic cavity. One male had an "upside down" stomach and the diaphragm failed to close on the left side. Two of the males had accessory lobes or tufts at the base of the ears. The five females had accessory lobes below the ears and all were blind (bilateral microphthalmia). Four of the females had cleft palate and two were harelip. The kidneys in all of the females were near or in the pelvic region.

It was found that this blind condition occurs naturally under similar conditions on the farm. In December of 1935, near the end of the 1934-1935 drouth in Texas, one litter of blind pigs was located near Ralls and another near McLean, Texas. There were fourteen pigs in one and seven pigs in the other litter, all of which were born blind according to the owners of the dams of the pigs. The Station secured six pigs from one and five pigs from the other of these litters and also the mother of one of the blind litters. These pigs were brought to the Station for further study. Nine calves born blind during the above drouth period were also located and brought to the Station. These calves were located near Spur, San Angelo, Graham, and Colorado, Texas, where the drouth lasted more than one year.

The results this year have furnished more evidence relating to maternal deficiency of vitamin A as a cause for a variety of congenital defects in the offspring, including blindness, the failure of complete development of eye tissue, cleft palate, harelip, and the arrested ascension of the embryo kidney.

Certain phases of this project have been temporarily suspended.

F. Hale, G. S. Fraps, L. G. Browman.

DAIRY HUSBANDRY

The Quantitative Requirements of Vitamin A for Dairy Cattle

This project conducted in cooperation with the Division of Chemistry, has been undertaken to ascertain the quantity of vitamin A required in the feed to promote good health and normal growth in dairy heifers from weaning age through the second or third lactation, as well as to ascertain the quantities of vitamin A necessary in the feed for normal milk production and maintenance during the dry period.

One group of six calves of weaning age will be started on a level of 1500 micrograms of carotene per 100 pounds liveweight and other groups at higher levels. These calves will be weighed and measured at regular intervals. Blood samples may also be collected at intervals and assayed for vitamin A. Two groups of cows which have previously been partially depleted of vitamin A will be placed on rations furnishing 1,500 and 15,000 micrograms of carotene per 100 pounds liveweight and these two groups are to be alternated on the two levels of carotene consumption by the double-reversal method of feeding.

The relation between the vitamin A stored and the carotene and vitamin A of the blood will be studied by using new born male calves.

O. C. Copeland and G. S. Fraps.

Permanent Pastures for East Central Texas

During a period of three years, good stands of Italian rye grass and rescue grass plats of two acres each were reduced to barren plats as far as these two grasses were concerned. This indicates that for this section of the state it is necessary to reseed pastures yearly in order to have sufficient seed to insure a good stand of these grasses.

Some fertilizer experiments were conducted in cooperation with the Division of Agronomy on bermuda grass consisting of nine treatments repeated five times. During the summer these fertilized plats were clipped three times and both green and air dry weights of yields were obtained. Statistically significant differences were found between the various treatments for yields. Nitrogenous fertilizers had a much greater effect upon yield than either phosphorus or potassium. These treatments will be repeated again next year on the same bermuda plats and also in the winter and spring upon some plats of Italian rye grass.

E. B. Reynolds and O. C. Copeland.

Minerals Necessary in Commercial Dairy Feeds

This study has been continued with the original two groups of cows on no calcium mineral supplement for one group and one per cent of

limestone in the grain mixture of the other group. These two groups of cows have completed three lactation periods on the two levels of mineral feeding but the results of production have not yet been analyzed. Milk and fat production for both groups of cows decreased with each succeeding lactation during the progress of the experiment.

O. C. Copeland.

Vitamin A Requirements for Milk Production and Maintenance of Dairy Cows

This project has been actively continued during the past year in cooperation with the Division of Chemistry. The work involved a duplication of the work of the previous year, using three cows in the place of one on each level of carotene fed. The results conform rather closely to the results reported last year that the dairy cow is somewhat inefficient in utilizing the carotene in her feed for the production of carotene and vitamin A in the butter fat, and that green feed is essential for the cow to produce butter fat containing up to 40-50 units of vitamin A potency per gram. A Station bulletin will be published on this work in a few months.

G. S. Fraps and O. C. Copeland.

Cottonseed Meal and Hulls As a Ration for Lactating Dairy Cows

This project will be completed at the end of this calendar year. The one group of cows has been continued on the ration of cottonseed meal, cottonseed hulls, and sorghum silage. Three of the four cows in this group have failed to breed and it is very likely that they are sterile as their oestral periods are very irregular. One cow from this group died in August after having been on the ration for six years and eight months. Although the post-mortem has not been completed on the cow, she apparently died from starvation. She lived for about a month after going off feed except for a few pounds of silage she consumed daily. A complete report of this project covering a period of approximately eleven years will be published as a Station bulletin in the near future.

O. C. Copeland.

Bangs Bacillus Disease (Bovine Infectious Abortion)

This study has been actively continued during the year in cooperation with the Division of Veterinary Science. Thirty-four cows completing production records in the abortion-free herd averaged 7,428 pounds of milk and 383 pounds of fat for a ten-months record corrected for age. Fourteen cows completing records in the abortion-infected herd produced an average of 7,292 pounds of milk and 372 pounds of fat for a ten-months age corrected record. The birth weights of forty-three

calves born during the year in the abortion-free herd averaged 52.7 pounds including thirteen calves from heifers calving the first time, whereas the average birth weights of fourteen calves born in the infected herd was 48.6 pounds and all were from mature cows. A report of the agglutination tests and breeding performance for the two herds can be found in the report of the Division of Veterinary Science.

H. Schmidt and O. C. Copeland.

Ground Versus Unground Grain for Lactating Dairy Cows

(In cooperation with the School of Agriculture,
A. & M. College of Texas)

This project was completed during the year and the results were published in Bulletin No. 530. It was found that greater milk production was obtained from feeding ground grain in all of the grains tested over that obtained when whole grain was fed. Most of the greater amount of milk produced on ground grains could be accounted for by the greater amount of grain consumed during the periods ground grain was fed. Most of the cows showed a dislike for the whole grain mixture and would not consume as much as they should have according to their level of milk production. A detailed discussion of this study can be found in Station Bulletin No. 530.

A. L. Darnell and O. C. Copeland.

POULTRY HUSBANDRY

Vitamin A Requirements of Chicks

Work on this project, conducted in cooperation with the Division of Chemistry, has been continued along the lines reported in the forty-eighth Annual Report. During the year of 1934-1935, six lots of old hens were continued on all-mash rations containing 60 per cent yellow corn from 0 to 4 per cent dehydrated alfalfa leaf meal. The average number of eggs laid per hen, and the percentage of eggs that hatched, were as follows:

	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
Percentage of yellow corn.....	60	60	60	60	60	60
Percentage of dehydrated alfalfa leaf meal.....	0	2	4	2	3	4
Average number of eggs laid per hen.....	42.7	58.6	87.6	83.2	96.9	89.1
Percentage of total eggs which hatched.....	3.8	40.8	28.0	59.3	55.0	62.6

The hens on rations 1 to 3 were older than hens on rations 4 to 6, and had been on the same rations the previous year.

In the studies to determine the vitamin A requirements of chicks, the experiments showed that the vitamin A in the feed of the hens

laying the eggs from which the chicks were hatched has a direct effect on the results with the chicks.

These experiments showed that chicks hatched from eggs laid by hens receiving 265 Sherman-Munsell units of vitamin A per day (or 325 units per 100 grams of feed) had low vitality. The mortality of the chicks for the first eight weeks on different vitamin A levels varied from 64.4 per cent for the chicks from the hens receiving 265 units a day (or 325 units per 100 grams of feed) to 38.5 per cent for the chicks from the hens receiving 539 units per day (or 655 units per 100 grams of feed). The mortality for the chicks from the hens fed the feed low in vitamin A was high regardless of the feed of the chick. Feeding the chick 300 units of vitamin A per 100 grams of feed did not overcome the effect of a deficiency of vitamin A in the feed for the laying hens; but the vitamin A requirements of chicks are higher for those hatched from eggs laid by hens receiving low amounts of vitamin A than for hens fed more liberal amounts. The experiments indicate that from 125 to 150 units of vitamin A potency, or 96 to 110 micrograms of carotene from alfalfa, or 114 to 136 micrograms of cryptoxanthin and carotene from yellow corn per 100 grams of feed, is sufficient for chicks hatched from eggs rich in vitamin A. Chicks hatched from eggs laid by hens receiving low amounts of vitamin A require larger amounts, possibly as high as 300 units of vitamin A potency, or 230 micrograms of carotene from alfalfa, or 270 micrograms of carotene from yellow corn per 100 grams of feed.

R. M. Sherwood and G. S. Fraps.

Vitamin D Requirements in Chickens

In this project, conducted in cooperation with the Division of Chemistry, three levels of vitamin D, 6, 12, and 18 International (U. S. P.) Units of vitamin D per 100 grams of rations, were studied during 1936, each on levels of 1.24 per cent and 1.44 per cent of calcium with 0.78 per cent phosphorus. The difference in the weights of the chicks in the group receiving the different levels of vitamin D and calcium was not consistent, and was in the limits of error. The main percentage of bone ash of chicks in the group receiving 6 units of vitamin D per 100 grams of feed was significantly lower than that of the chicks in the groups receiving higher levels of vitamin D, regardless of the calcium content of the rations. The larger amounts of vitamin D used in the 1936 work (6 to 18 units per 100 grams of rations) seemed to eliminate the differences due to changing the calcium content of the rations, as noted in the 1935 work where the highest level of vitamin D feed was approximately 100 grams of feed. In the hen studies, three levels of vitamin D, 3, 14, and 25 International Units per 100 grams of rations were fed to White Leghorn hens that were just beginning their first laying year. These hens were maintained in individual

batteries in the absence of sunlight for a period of seven months. The hens in the group receiving 3 units of vitamin D per 100 grams of feed produced a significantly smaller number of eggs, required about two and one-half pounds of feed to produce one dozen eggs, and had a higher mortality than the group receiving a higher level of vitamin D. There was very little difference in the number of eggs produced, pounds of feed used to produce twelve dozen eggs, and mortality between the two groups receiving 14 and 25 International Units of vitamin D per 100 grams of feed.

J. R. Couch, G. S. Fraps and R. M. Sherwood.

Slipped Tendons and Feathering Vitamins

Two different experiments were conducted on this project, in cooperation with the Division of Chemistry, during this year using a total of 450 chicks. The basal diet, known as diet 1, was compounded of ground kafir 20 pounds, ground yellow corn 56.87 pounds, meal and bone scrap 9 pounds, dried skimmed milk 9 pounds, dehydrated alfalfa leaf meal 3 pounds, chick size oyster shell 1 pound, salt 1 pound, and fortified cod liver oil .13 pounds. Diet 2 varied from diet 1 in that the ethylene dichloride extract of 20 pounds of gray shorts replaced an equal weight of ground kafir in diet 1. In diet 3, an alcohol extract of the residue from the preceding extraction replaced an equal amount of ground kafir in diet 1. In diet 4, the residue of ethylene dichloride and alcohol extracts replaced an equal weight of ground kafir of diet 1. In diet 5, the ash of another 20-pound portion of wheat gray shorts replaced an equal amount of ground kafir in diet 1. In diet 6, 20 pounds of wheat gray shorts replaced the ground kafir of diet 1. These diets were fed for fourteen hours per day for twelve weeks. The slipped tendon or perosis indexes were figured from data secured from observations made at the close of the experiment. These indexes were calculated as follows: Each chick was given a value of 0, 1, 2, or 3, to correspond with no slipped tendons, a slight case, a medium case, or severe case. These values are summated and divided by three times the number of chicks, and this quotient is multiplied by 100. The higher the index, the more severe the trouble. The accompanying table gives the data on the number of slipped tendon and the slipped tendon index for the chicks on the different diets. The basal ration, diet 1; the ethylene dichloride extract of wheat gray shorts, diet 2; and the alcohol extract of wheat gray shorts, diet 3—all produced practically the same high slipped tendon index. The basal diet with the addition of the residue from the extraction of wheat gray shorts with ethylene dichloride and alcohol, diet 4, the basal diet with the addition of the ash of wheat gray shorts, diet 5, and basal diet with the addition of wheat gray shorts, diet 6—all produced practically the same low diets.

These experiments suggest that the factor in wheat gray shorts which prevents slipped tendon or perosis is not an organic substance as has been concluded with other experiments with other feeds, but is one or more of the mineral constituents of the ash.

Summary table giving number of chicks for slipped tendon and slipped tendon index for the various diets:

Summary table giving number of chicks for slipped tendon and slipped tendon index for the various diets.

	Num- ber of chicks	Number with			Slipped tendon index
		Slight slipped tendon	Medium slipped tendon	Bad slipped tendon	
Diet 1. Basal ration.....	58	13	12	8	35.1
Diet 2. Ethylene dichloride extract of wheat gray shorts.....	52	11	16	7	41.0
Diet 3. Alcohol extract of wheat gray shorts.....	60	17	10	11	38.9
Diet 4. Residue from the extraction with ethylene dichloride and alcohol.....	66	5	3	1	7.1
Diet 5. Ash of wheat gray shorts.....	57	5	2	1	7.0
Diet 6. Wheat gray shorts.....	64	1	1	2	4.7

R. M. Sherwood and G. S. Fraps.

Mineral Requirements for Laying Rations

It was reported in the forty-eighth Annual Report of this station that 4 to 5 per cent of oyster shell gave good results in all mash laying rations. Egg production was not increased by larger amounts of oyster shell and the percentage of the eggs to hatch was lower with 7 per cent oyster shell in the mash than with 4 or 5 per cent of shell.

The work reported last year was the study of varying amounts of calcium in laying mash, the calcium being supplied by crushed oyster shell. The work was continued this year using ground limestone as a source of calcium. One ration containing 4 per cent oyster shell was used as a check. The other rations contained 0, 2, 4, and 6 per cent ground limestone in their mash. The hens receiving no limestone in their mash were allowed free access to limestone in granular form. These hens were fed all mash rations. These rations were fed both in cages and in pens. On the work this year the hens receiving 4 per cent of oyster shell and 4 per cent limestone gave higher production than did hens receiving larger amounts of ground limestone.

R. M. Sherwood.

Mineral Requirements of Commercial Turkey Rations

The work reported in the Forty-eighth Annual Report was continued this year. Four rations containing 2 per cent oyster shell and 2 per

cent bone meal, 3 per cent oyster shell and 2 per cent bone meal, 3 per cent oyster shell and 3 per cent bone meal, 4 per cent oyster shell and 3 per cent bone meal, were fed for twenty-four weeks to young turkeys in rations containing approximately 6 per cent sardine meal, 6 per cent cottonseed meal, 6 per cent soy bean meal, 4 per cent dried buttermilk, 10 per cent dehydrated alfalfa leaf meal, 33 per cent ground yellow corn, 3 per cent ground whole oats, 1 per cent salt, and 4 per cent tobacco dust. The percentages of calcium in the different rations were 1.69, 2.08, 2.30, and 2.69. The percentages of phosphorus were 0.83, 0.83, 0.93, and 0.93; and the calcium-phosphorus ratios 1:50, 1:40, 1:40, and 1:35.

Studies were made of growth, number, and severity of slipped tendons, and the severity of crooked breast bones. These data, although not conclusive, indicate the formula which contained 3 per cent oyster shell and 2 per cent bone meal gave more satisfactory gains and bone formation. The formula containing 3 per cent oyster shell and 3 per cent bone meal gave second best results. These formulas contained 2.08 per cent calcium, 0.83 phosphorus with a calcium-phosphorus ratio of 1:40 and 2.30 calcium, 0.93 phosphorus with the calcium-phosphorus ratio of 1:40 respectively.

R. M. Sherwood.

Calcium and Phosphorus Requirements for Chicks

Four experiments were conducted on this project to study different calcium and phosphorus levels with all mash chick rations containing varying amounts of wheat gray shorts.

The same calcium-phosphorus ratio 1:47 was maintained in all rations. Three rations containing 10, 20, and 30 per cent of wheat gray shorts contained 1.10 per cent calcium and .52 to .35 per cent phosphorus, while three other rations containing the same quantities of wheat gray shorts contained 1.37 per cent calcium and from .66 to .69 per cent phosphorus. The calcium and phosphorus in the rations were held at these levels by varying the amounts of oyster shell and bone meal.

The chicks receiving the higher levels of calcium and phosphorus made slightly higher gains than those on the lower level regardless of how much wheat gray shorts the chicks received. The larger quantities of wheat gray shorts gave faster gains regardless of the levels of calcium and phosphorus. It is true that as the levels of shorts were increased, the amounts of calcium and phosphorus from oyster shell and bone meal were lower than with the lower levels of wheat gray shorts.

R. M. Sherwood.

RURAL HOME RESEARCH

Growth in Weight and Height of Texas School Children

A manuscript has been prepared reporting upon the comparative size, certain aspects of body build, and average rates of growth of Mexican, white, and negro school children in the three public schools of San Antonio that cooperated during $2\frac{1}{2}$ school years in this study. The data analyzed were secured from 928 white children 7 to 13 years of age, 790 Mexican children of 8 to 15 years, and 725 negro children from 7 to 17 years. Over 2500 measurements of weight, standing height, and sitting height were made of the white and negro children, and over 2300 of the Mexican. Measurements of shoulder width and hip width totaled a little over 1000 for white children and a little under 1000 for both the Mexican and negro children.

The mean for each of the five body measurements was calculated for each year of age for each sex in each race. In all cases, weight increased at much the fastest rate, followed in general in descending order by hip width, standing height, shoulder width, and sitting height. Strikingly similar sex relationships were exhibited by the three races with respect to a given measurement. In weight, in standing height, and in sitting height girls at younger ages had smaller mean values than the boys; but in all three races, between 9 and 10 years or 10 and 11 years, the girls gained advantage over the boys and held this position until 14 or 15 years, when means for the boys were again the greater. However the differences between negro boys and girls were much more marked for standing and sitting height than for Mexican and white boys and girls.

Most of the means of shoulder width for the boys and girls of the same age in each race were nearly equal. But in the few age groups in which the means were not the same, the slight difference was consistently in favor of the boys, except for 12-year and 13-year-old negro girls, who surpassed the boys.

In hip width, mean values were higher for the negro girls 9 years of age and over and for white and Mexican girls 8 years and over. Sex differences in means were more pronounced from 11 years on for white children and from 12 years on for Mexican and negro, except at 16 years negro boys and girls had nearly the same mean.

As determined by the relation of the difference between corresponding mean measurements to the probable error of the difference, the boys and girls of the negro race were found to differ significantly from each other more often and more markedly than did white or Mexican, in case of weight, of standing height, and of sitting height. Shoulder width showed a significant difference of mean for only the 7-year white boys and girls, only the 9-year Mexican, and 8-, 16-, and 17-year-old negroes. Hip width showed the most consistently occurring significant

differences between boys and girls for the three races, these being in 5 of 7 age groups for the white children, in 4 of 7 age groups for the Mexican, and in 4 of 9 age groups for negro children.

Comparing one measurement with another, weight was by far the most variable, the coefficients of variation being approximately 2 to 3 times as large as for shoulder width and hip width, and approximately 3 to 4 times those for standing height and sitting height in corresponding groups. The tendency to somewhat higher coefficients of variation in adolescent age groups (10 to 14 years) was not perfectly consistent.

Negro and white children displayed opposite trends in relation of coefficients of variation in standing height to age, there being an increase in variability with age for white children and a decrease for negro.

The average annual gain in each measurement was calculated by subtracting the means of each two consecutive year-of-age groups for each sex in each race. The weight gains for white children ranged from approximately 3 to 8 pounds; for Mexican, from 2 to 10½ pounds, for negro from 1½ to 11½ pounds. Larger absolute weight gains in years of adolescence were much better defined for Mexican and negro children than for white. The annual gain in standing height was roughly 2 inches and in sitting height roughly 1 inch for each race, with slight advantage of the negro over the other two races. Annual gains in both shoulder width and hip width for the most part fell between about ½ centimeter and 1½ centimeters, with somewhat larger proportion of the bigger gains among negro and Mexican than the white children.

Compared with white children, negroes before 9 or 10 years are lighter in weight, and thereafter heavier; in standing height, shorter till 9 or 10 years old and thereafter taller; in sitting height, continuously shorter from 7 to 12 years; broader through the shoulders after 8 years; and in hip width narrower, the difference being greater between girls than boys.

Compared with white children, Mexicans are lighter in weight, shorter in both standing height and sitting height, exceedingly little narrower in the shoulders, and slightly narrower through the hips.

Compared with negro children, Mexican children are lighter in weight, shorter in standing height, of narrower shoulder width and similar in both sitting height and hip width. On the whole, the rates of increase for white and Mexican children are quite similar in all five measurements—weight, standing height, sitting height, shoulder width, and hip width.

In general, the rate of increase in the five measurements is fastest for the negroes, being especially marked with weight, but distinct for the other four measurements except among boys for hip width in which the three races have nearly the same rates.

These findings add to the evidence of the need for separate racial standards for body measurements designed to be used as a partial basis for judging the nutritive and developmental state of a growing child, and provide some data which may be used for this purpose.

Jessie Whitacre.

Effect of tea upon the energy metabolism of children

The oxygen consumption of children 10 to 13 years of age is being measured by the use of a Benedict-Roth recording respiration apparatus. After a sufficient number of preliminary basal rate determinations to indicate that each child will be a suitable subject, tests are made to show the effect of 300 cc of ice tea (average caffein content .0292 gram as determined by analysis) and of 300 cc of lemonade containing the same amount of sugar and lemon juice as the tea and drunk at the same temperature. Lemonade is the test beverage in 2 or 3 experiments, and tea in 3 or 4 experiments with each child. In each experiment, immediately after a basal determination, the child drinks the beverage; then the oxygen consumption is measured at 30-minute intervals for 2 hours, and thereafter at 30 minutes or 1 hour until a total of 5 or 6 determinations has been made. Thus far, tests have been completed for eight children.

In general, the course of the oxygen consumption following tea ingestion was strikingly similar to that following lemonade. In no case was the maximum rise after tea consistently greater than after lemonade, although with three of the children there was a higher oxygen consumption in 3 of 4 tests with tea than with lemonade. But with all eight children the metabolic rate following either beverage had returned to basal level in from 1 to 3 hours (except for 1 test with lemonade for two children and 1 with tea for another).

The maximum percentage increases found in oxygen consumption over basal rate in the several tests for each child ranged as follows: (PM) lemonade 9.4 to 12.9, tea 6.3 to 31.9; (DH) lemonade 8.5 to 14.6, tea 10.0 to 17.2; (MD) lemonade 10.6 to 20.0, tea 12.9 to 21.6; (ER) lemonade 8.6 to 20.3, tea 7.7 to 26.4; (IJ) lemonade 14.8 to 17.7, tea 14.2 to 17.2; (JB) lemonade 7.7 to 24.0, tea 7.5 to 14.0; (JY) lemonade 15.0 to 25.5, tea 7.4 to 13.1; (DL) lemonade 10.9 to 15.4, tea 9.1 to 23.9. The average of the maximum consumption of oxygen per minute found for each child in each experiment with each beverage has been computed. In terms of these averages the comparative amounts of oxygen consumed by the eight children are: (PM) lemonade 194.7cc, tea 199.4 cc; (DH) lemonade 200.0 cc, tea 199.0 cc; (MD) lemonade 200.8 cc, tea 200.5 cc; (ER) lemonade 180.1 cc, tea 189.5 cc; (IJ) lemonade 188.2 cc, tea 188.6 cc; (JB) lemonade 178.2 cc, tea 175.1 cc; (JY) lemonade 194.4 cc, tea 176.7 cc; (DL) lemonade 205.7 cc, tea 212.9 cc. The difference between the highest and the lowest maximum oxygen consumption for each beverage was less than 10 per cent in 11 of 16

computations (2 for each of eight children) and not over 5 per cent in 7 of these computations. The remaining differences were 11.4, 11.2, 11.6, 15.4, and 18.2 per cent.

The time of the maximum rise found after both beverages was after $\frac{1}{2}$ hour for five children. For the other three children the maximum found after tea was after $\frac{1}{2}$ hour (except once after 1 hour for one child); after lemonade, after 1 hour for one child in 3 tests, after $\frac{1}{2}$ hour and 1 hour respectively for another child, and after $\frac{1}{2}$ hour for 2 tests and 1 hour in a third test for the third child. The latter two of these three children who had a slower rise after lemonade than after tea were two of the three for whom the maximum oxygen consumption was greater in 3 of 4 tests with tea than with lemonade.

Although still more data are needed for definite conclusions, the indications in this study are that caffeine, in the amount used, causes little if any increase in oxygen consumption. Jessie Whitacre.

Factors Affecting the Storage of Cucumbers

The second season's tests at the main station for this project which is cooperative with the Division of Horticulture were made in the summer of 1936. Of the 284 cucumbers shipped from Substation No. 19 at Winter Haven, 164 were wrapped individually in moisture-proof cellophane as soon as possible after harvesting, and 40 of these fruits were treated with a chlorine disinfectant before being wrapped. The remaining fruits from the substation were left unwrapped as were 45 fruits grown at College Station.

Three places of storage were used at the main station—an electric refrigerator set to maintain a temperature between 40° and 45°F, an open shelf in the laboratory beside the refrigerator, and shelves in a ventilated pantry in the "work center" of the Extension Service. The average temperature in the refrigerator after the first 24 hours was 41.6°F. as calculated from daily thermometer readings taken at 8 A. M. (except Sundays) during the storage period. The average temperature at 8 A. M. on the laboratory shelf was 87.6°F.; that in the ventilated pantry 69.4°F. at 8 A. M. A recording thermometer kept in the pantry showed the difference between maximum and minimum temperature within 24 hour periods to range from 2°F. to 12°F. Approximately equal lots of cucumbers (38 to 43 fruits) from the substation were placed in each storage place. In the refrigerator were all the wrapped disinfected fruits; a lot of wrapped fruits; and a lot of unwrapped, a portion of which were placed in a refrigerator humidifier. On the laboratory shelf, and also in the pantry, were a lot of wrapped and a lot of unwrapped fruits from the substation, and one-half the fruits grown at College Station.

The first shipment of cucumbers from Winter Haven went into storage May 28; the second, June 4; and those from College Station on June 8.

The fruits remained in storage until evidence of deterioration appeared or until they were used as samples to be judged for quality of stored cucumbers. The longest storage period was 41 days, but most of the fruits were held not over 32 days.

Each fruit was weighed every other day during the first 2 weeks, and thereafter twice weekly. The percentage loss of net weight was calculated for each fruit at the time it was tasted or discarded. While in general the loss in weight tended to increase with length of storage period, there were many exceptions with individual fruits, and the average percentage losses for a given length of storage were not always consistently greater than for the next shorter storage period and smaller than the next longer period. No correlation was found between the number of lenticels and loss in weight. The protection afforded against loss in weight by wrapping, placing in a humidifier, and the lower temperatures used (other conditions being comparable) is indicated by the figures in the following table. The storage periods are those at which the fruits were discarded or judged unsalable.

Treatment	No. fruits	Days stored	Range in percentage loss in weight	Average percentage loss in weight
Disinfected and wrapped (refrigerator).....	25	22 & 25	1.54 to 5.06	2.9
Wrapped (refrigerator).....	17	22 & 25	0.69 to 3.47	2.5
Unwrapped (refrigerator, humidifier).....	7	21	5.06 to 8.91	6.5
Unwrapped (refrigerator).....	15	22 & 25	4.57 to 23.75	17.0
Unwrapped (pantry).....	14	25	5.74 to 15.25	11.1
Unwrapped (laboratory).....	30	21 & 22	10.69 to 28.87	19.9

A judging committee of the same individuals (usually six in number and never less than four) tasted and rated representative cucumbers from the several treatments after 1 to 34 days of storage. The score card devised especially for this purpose calls for separate rating upon turgidity, texture, and flavor, and a summary judgment of palatability, considering at once the various qualities involved. Of the 63 cucumbers tasted, the judges agreed unanimously that only two (both unwrapped, and stored but one day) were without abnormality in flavor, and one of these received the highest score given for palatability, 16.2 points out of a possible 18. Only 4 other fruits received a rating above 12 points (good to excellent grade), their storage period being 2, 2, 12, and 14 days respectively. The corresponding percentage losses in weight of these six fruits were 0.9, 1.6, 3.5, 2.6, 5.5, and 1.3. Fifteen fruits were rated fair to good in palatability (above 6 points but less than 12). Their storage periods ranged from 4 to 34 days; 4 were wrapped fruits; 8 (3 of them wrapped and 5 unwrapped) were stored in the refrigerator, the remainder in laboratory or pantry. Turgidity was rated higher in general for the wrapped than the unwrapped fruits, the scores ranging from 4.5 to 9.0 out of a possible 9 points for the wrapped and from 2.5 to 7.8 for unwrapped after 14 to 34 days of storage. Scores for both texture and flavor were more nearly in agreement for wrapped and un-

wrapped fruits than were scores for turgidity, and were usually but not invariably somewhat lower than the turgidity scores, for the fruits rating less than 6 points on palatability.

Additional tests are planned for the 1937 season. Results thus far indicate that loss in weight during storage of cucumbers may be reduced either by wrapping in moisture-proof paper, or placing in a covered pan in the refrigerator, but deterioration in other factors of palatability, as texture and flavor, is not retarded.

Jessie Whitacre, L. R. Hawthorn, S. H. Yarnell.

The Effect of Oven Temperatures on the Tenderness of Meat

In this study, the problem has been limited to only one of the factors (oven temperature) which may have an influence on the problem of the best method of cooking for the highest degree of palatability and to only one of the factors of palatability (tenderness). The problem was limited in this way in order to study intensively the relationship between oven temperature and tenderness.

In the first series, the cuts were cooked well done. They included the 9th, 10th, and 11th ribs, the round-bone chuck, and the rump roasts of beef, the half-ham of pork, and the leg of lamb. In the second series, the cuts were cooked medium-rare and included only the 9th, 10th, and 11th ribs and the round-bone chuck roasts of beef.

The roasts in the first series were cooked at constant oven temperatures of 125°C and 225°C to an internal temperature of 80°C (well-done). Carefully paired samples from 164 roasts were tested for tenderness by a committee of judges who used the paired-eating method as well as a rating scale of adjectives.

The results from the paired-eating method show that the roasts fall into three groups: first, the roasts which showed the largest percentage of judgments in favor of the low oven temperature method, round-bone chuck 96 per cent and rump 93 per cent; second, the roasts which showed a majority, but a lower majority, of judgments in favor of the low oven temperature method, half-ham 75 per cent and rib 69 per cent; and third, the roasts which showed no significant majority in favor of the low oven temperature method, leg of lamb 51 per cent.

It was observed that the corresponding time-temperature curves for each of these cuts fell into the same grouping as did their tenderness results, the decrease in slope as the cooking continued being accentuated in the chuck and rump roasts, being noticeable but not so pronounced in the half-ham and rib roasts, and being only slightly noticeable in the leg of lamb roasts.

The difference in total cooking time between the high and low oven temperature methods, also, fell into the three groups: chuck 370 min-

utes and rump 309 minutes; half-ham 195 minutes and rib 194 minutes; and leg of lamb 105 minutes.

These observations suggested that the results for tenderness in Series 1 were due to the longer time of cooking and not to oven temperature per se. Accordingly, in a second series of experiments, 22 rib and 21 chuck roasts were cooked at constant oven temperatures of 125°C and of 225°C so as to obtain an internal temperature of 63°C (medium-rare), a point on the time-temperature curve preceding the accentuated decrease in slope shown by the chuck roasts and a point at which the difference in cooking time between the two cuts is relatively small. At this point, also, the curves for the two methods of cooking for each cut are fairly close. The results show that there was no significant difference in tenderness either between the two cuts or between the two methods of cooking.

The evidence presented points to a relationship between tenderness and slow cooking. Any apparent relationship between tenderness and oven temperature may be explained in an apparently satisfactory manner on the basis of length of time required for cooking.

Station Bulletin No. 542 gives the details of this study.

S. Cover.

Processing of Canned Meat

In this project, conducted in cooperation with the Division of Veterinary Science, the meat from three Jersey cows and one calf—slaughtered, boned, and ground in the meats laboratory—was canned in No. 1, No. 2, and No. 3 tin cans using various processing times and pressures. Most of this meat was stored for three months at 110°F. in a room especially designed to maintain constant temperature conditions. The processing period at both 10 and 15 pounds pressure were 45, 60, 75, and 90 minutes for No. 1 cans; 50, 60, 75, 90, and 105 minutes for No. 2 and No. 3 cans; and in addition No. 3 cans were processed at 15 pounds pressure for 45 and 120 minutes. Twenty-five of the No. 1 cans leaked because of an unknown type of flaw in the can. Two of the No. 2 cans swelled. The rest kept perfectly. A bacteriological examination of one can in each lot and of the two swelled cans showed no viable organisms. No toxin was found in the swelled cans. Observations on appearance and flavor showed little difference between the long and short processing periods.

The white meat from 140 hens was canned as boned chicken in 56 No. 1 cans. The dark meat and the small pieces were canned as ground chicken in 150 No. 1 cans. Ten pounds pressure was used for 45, 60 and 75 minutes and 15 pounds pressure for 45 and 75 minutes. None of the canned chicken spoiled during the storage period of three months at 110°F. One can from each lot was examined bacteriologically. No viable organisms were found.

Although a total of 889 cans of meat has been used in these tests, definite recommendations are being delayed awaiting further tests of a different kind.

S. Cover and H. Schmidt.

A Study of Various Methods of Storing Cured Bacon in Different Oils

In this project, conducted in cooperation with the Division of Swine Husbandry, preliminary tests with sliced bacon stored at 110°F in air and in cottonseed oil in various types of containers have shown some advantage in favor of the cottonseed oil, but all of the bacon was unfit for table use after continuous storage for five months at this high temperature. This observation does not indicate, however, that storage under ordinary summer temperatures would give similar results if a temperature of 110°F. were reached only occasionally.

S. Cover and Fred Hale.

Physical and Chemical Analyses of Rib Cuts

In cooperation with the Division of Range Animal Husbandry, Bureau of Animal Industry, and Bureau of Plant Industry, rib cuts from three steers in each of the four lots were obtained after the Big Springs cattle were marketed. The cuts were taken from carcasses which were (1) an average of the best in each lot, (2) an average of the poorest in each lot, and (3) an average of the entire lot. The cuts consisted of the 9th, 10th, and 11th ribs from the right side of the carcass. Physical separation into fat, eye-muscle, other lean, lean-fat, and bone were made for each cut and the percentages calculated on the basis of total weight of the cut. Each of these samples for each cut was then analyzed for nitrogen, fat, and moisture. The percentages in this case were calculated as crude protein, crude fat, and moisture in the physical sample and in the entire cut as well. The physical sampling and the chemical analyses were made by John K. Riggs, a graduate student in the Department of Animal Husbandry.

S. Cover, J. M. Jones, and F. E. Keating.

The Effect of Exposure in the Field on Grade, Strength, and Color of Raw Cotton

In cooperation with the Division of Agronomy, this study was undertaken to measure the extent to which the cotton was lowered in grade, staple, strength, and color when exposed in the field under normal weather conditions for various periods of time.

The cotton used was of the same variety, grown for two seasons at Temple, Chillicothe, and Lubbock, regions where soil and climate differ. The grade, strength, and color of unexposed cotton and cotton exposed

from 1 to 33 weeks were determined. A drop of one grade had occurred after one week of exposure at one station and after an average of less than 4 weeks for all stations and seasons. A drop of 4 and 5 grades, a decrease in length of from 1/16 to 3/16 inches, and a decrease in price of from 150 to 265 points occurred during exposure. The monetary loss due to exposure was in some cases nearly one-half the price of the unexposed cotton, or at the exceedingly low prices of 1932 and 1933, approximately \$13.00 per 500 pound bale.

All of the cotton lost strength, but not equally, upon exposure. There was an average loss of 4 per cent after 4 weeks and a maximum loss of approximately 14 per cent for the season. Cotton grown at Temple lost the lowest and that at Lubbock the highest percentage of the original strength. These differences were not due entirely to differences in rainfall but may have been due in part to greater ultra-violet in the sunlight at the higher altitude.

There were regional and seasonal differences in the color. All cottons became darker and less creamy as the exposure increased. In all cases there was a decrease in either creaminess or brightness, or in both, within 3 to 5 weeks after opening. Precipitation apparently caused greater darkening than it did loss in creaminess. The grades appear to follow brightness more closely than they do creaminess.

It is concluded that cotton should be harvested, so far as is practicable, not later than 4 or 5 weeks and preferably within 1 or 2 weeks after opening to assure a product of high quality in grade, strength, and color.

Three lots of lint cotton stored in a vault for one year had lost respectively 7, 15, and 18 per cent of their original strength, and after two years of storage two lots had lost 25 and 33 per cent. Since some workers have reported an increase in strength upon storage it is planned to make further study of this problem.

The details of this study are being published in Bulletin No. 538.
Mary Anna Grimes.

Physical Characteristics in Cotton and Their Interrelationship

Half and Half and Lightning Express with succeeding generations of hybrid lines resulting from a cross of these two varieties are being furnished for this study by the Division of Agronomy.

For the most part efforts have been confined to the development of techniques suitable for use in measuring the characteristics under consideration. The maturity of the cotton is being determined with a polarizing microscope. Various methods for determining the fineness of the fibers are being tried, particularly methods for measuring the cross-sectional areas.

In selecting a method for determining the breaking strength of the cotton fibers further comparisons have been made of three methods: (1) the Chandler bundle; (2) the flat bundle in which the parallel fibers were weighed and placed uncut between tape and with the cotton classer's estimate of length used in the calculations; and (3) the flat bundle cut to $\frac{1}{2}$ inch length, weighed, and taped.

The strength obtained by the taped methods may be determined by either of two methods. The strength per cross-sectional area may be calculated or the strength in pounds per gram of cotton of this length may be obtained by dividing the machine break by the weight. The latter method is of course simpler and is satisfactory for comparison of cottons broken by the same method but neither can be converted into terms comparable to the results obtained by the Chandler method.

The method using uncut fibers was found to be less satisfactory than either of the other two methods. It is believed however that it is suitable for routine work where great accuracy is not demanded, and when used in conjunction with fiber arrays may prove to be sufficiently accurate for research purposes. The cut-weighed-taped method and the Chandler bundle were found to give equally satisfactory results.

The taped methods have the advantages over the Chandler of eliminating the use of a wrapping device and special jaws for the breaking machine, give fewer unsatisfactory breaks due to slippage, and save considerable time and labor.

The cut-weighed-taped method has been chosen for use in this study.

Technical articles concerning these methods have been accepted for publication in *Textile Research* and in *The Textile World*.

Mary Anna Grimes.

APICULTURE

The Apicultural Research Laboratory is located near San Antonio with a yard near Dilley and outyards in cooperation at Roxton and Seguin.

Activities of Bees

The data taken in this project during the present year show most definitely the relationship existing between the weather, the nectar-bearing plants, and the honeybee. The last three months of 1935 were dry; the first three months of 1936 were dry; the result, the winter annual plants from which come the early honey flow did not germinate, which bloom only during periods of drought came into bloom. Between Mesquite and guayacan, together with some other semi-arid plants April 10 and May 7, the mesquite association gave an average of fifty-

two pounds surplus honey. As the mesquite will drop its bloom and commence vegetative growth immediately upon the addition of considerable moisture, a rainfall of 1.20 inches on May 8 put an end to this spring honey flow. The remainder of the month of May was cloudy and rainy. Some belated horsemint came into bloom. The honey flow, however, was not sufficient to feed the increasing brood. Bees like plants responded to the coming of cooler and more moist conditions by raising a field force which had been delayed because of the drought for nearly two months. The first part of June was dry. Horsemint and belated spring annuals gave a sufficient honey flow to supply the growing brood and to store a very small surplus. The first half of August was dry and hot, during which period the native plants showed the ordinary midsummer flowerless period. The middle of September witnessed the beginning of fall rains and cloudy weather which continued throughout the year. Fall brood rearing began September 14th. Due to the fact that much of the period was rainy, the bees utilized the stores remaining from spring to raise brood. At one time during the first weeks of October, the bees were enabled to store a small amount from broom weed. At the end of the year the bees have abundant stores for winter and have a full field force. This relationship among the three factors shows very definitely that, although there may be a normal bloom of honey plants throughout the season of the year when honey is generally stored, the presence of both drought and rain can change what would appear to be a year of a normal honey crop to one in which no surplus can be removed.

H. B. Parks.

Adaptability of Native Plants

If beekeeping is to again regain its place among the agricultural pursuits and to be a profitable enterprise in the State of Texas, the native honey flora which has almost disappeared due to the breaking up and pasturing of the land must be in some way restored. There are two plants raised on a large scale in Texas which give the bees yields of nectar. The first is the cotton plant which secretes nectar only when grown on black or alluvial soils, thus restricting its acreage. The application of poison to the cotton plants rendered beekeeping in the cotton zones a hazardous enterprise. Sweet clover in Texas east of the thirty-inch rain line will grow very nicely and will maintain itself. It is well adapted for erosion control and is an addition to pasturage. It also would make a hay crop if such was needed in that section of the state; however the plant is not popular with the farmers. It is apparent that if the honey flora is to be restored every opportunity must be taken to induce the propagation of honey plants. To this end much attention has been given to the adaptability of native plants to the needs of man, stressing the use of those that are nectar-bearing, as in this way large numbers of nectar-bearing plants will be utilized

for farm and home ornamentation, erosion control, and road and park beautification. To this end large numbers of native plants have been grown and studied in order that they might be recommended for definite uses with the surety that they would give the results needed. During the present year the following native plants, which have been on experimentation for a sufficient time, were recommended.

Thurberia thespesoides Gray, the Arizona Wild Cotton. A beautiful shrub which will withstand cold to twenty degrees, produces numerous branches which bear many cotton-like flowers from April until October. This plant was grown in the immediate vicinity of cotton fields for nine years and has not shown susceptibility to cotton root rot nor has weevil attacked its bolls. The plant can be grown from cuttings or seed.

Eryngium Leavenworthii T. & G., Purple Eryngium. A winter annual growing to the height of three feet, native throughout central and west Texas. The plant is a beautiful ornamental. The leaves are almost holly-like. In August and September it produces numerous clusters of flowers which are a brilliant purple. The bracts surrounding the flower cluster show greens and yellows. When the seed ripens the head again turns green. As a living ornamental this plant attracts much attention. If cut and dried while in full bloom it retains its brilliant color through the year; it is easily grown from seed which must be planted in October or November.

Eryngium yuccifolium Michx., Button Snakeroot. Native of central and east Texas but will grow anywhere it is given some water. It is a yucca-like plant which through the latter part of summer bears numerous globular clusters of small white flowers. This plant is highly nectar producing; however it blooms during the quiescent period of summer. It is quite desirable as it keeps the bees busy during this period. The plant attracts much attention because of its peculiar appearance. It grows to a height of four feet and can be raised from seed or by root division.

Hibiscus militaris Cav., Halbard-leaved Hibiscus. Shrub native to damp localities and swamps in east Texas; will grow anywhere in the State that it is supplied with a small amount of moisture. It is native as far north as St. Louis, Mo. It can be grown easily from seed and an individual plant will live throughout several seasons. In swampy lands it grows from four to five feet high, and is cultivated in yards about two to three feet. Throughout the summer it produces an abundance of large white flowers with red centers. The bees are very fond of the pollen and collect some nectar from it.

Hibiscus cardiophyllus A. Gray, Red-flowered Hibiscus. A plant little known but native to the territory between San Antonio and Laredo; a perennial shrub growing to the height of three to four feet; evergreen

during a majority of years and blooms during the warmer season. During the growing season a plant will have a few flowers every day. These are about one and a half inches in diameter and a brilliant red. The bracts and calyx lobes are sufficiently large to make this flower very noticeable. The plant is easily grown from seed or root division. It needs but little care, will grow anywhere in the State, and should be utilized as a specimen plant or hedge.

Jatropha cathartica (Berl.) Johnston. This is a little known plant native of southwest Texas. It is close kin to the common stinging nettle. It resembles a miniature castor bean plant. The leaves are similar to that species in form but are quite small. It bears umbels of small red flowers from June to October. The plant is a long-lived perennial growing from a heavy tuber. It is propagated by growing from seed and will bloom during its second year. It makes an excellent and unique border plant; recommended for the southeastern fourth of the State.

Observing that bees work the flowers of the tung oil tree abundantly, in 1934 seed was obtained from Substation No. 11. In the spring of 1935 twenty-four seeds were planted here. Twenty plants resulted. These trees are now in fine winter condition and average four feet in height. It is hoped that these trees will continue to live on the Eocene soils in eastern Bexar County as they will make a fine addition to the flora of this section. On the limestone soils in the western part of the county, experiments conducted several years ago on the U. S. Experiment Farm proved a failure.

During the present year about fifty species have been placed in the testing plants.

H. B. Parks, A. H. Alex.

Queen Rearing

Queen rearing was continued according to the long-time schedule and abundant material secured for the project. In former years queen rearing was normal during spring and fall but was rather difficult from June 20th to August 20th. This year the continuation of rain throughout the summer made queen rearing easy during this period.

A. H. Alex, H. B. Parks.

Bee Production

Observations made on the productive activities of the honeybee this year gave much information as to honey storage. The period during which some nectar was stored was four months and a half. The source of this nectar was mesquite and horsemint. The quality of the honey was good but was very largely used by the bees themselves so that no honey crop was taken. This is a third year in the fourteen during which the bees have been kept here that no surplus was removed from

the hives. The Roxton Yard located at the northern end of the cotton zone made the first crop for four years. This was due to the fact that rains occurred in that section and the cotton plants were nectar producing. Yields up to one hundred fifty pounds were reported from reliable commercial honey producers. The quality of this honey is reported as being of the best. At Dilley a forty-six pound average was taken. The source of this honey was guajillo and mesquite. The Seguin Yard made an average of sixty-three pounds of normal cotton honey.

H. B. Parks, A. H. Alex.

Horsemint for Honey and Oil Production

Considerable information as to the distribution of horsemints of Texas was procured during this year as well as confirmation of the theory that the annual horsemint must have rain in November and December if there is to be a crop of that plant the next year. The survey also showed that horsemints occur in large quantities along the coast region of Texas where they occur each year without regard to rainfall.

H. B. Parks, V. L. Cory.

Relationship of Honey Plants to Insects

In the observations made on this project during the past years it was postulated that because of drought native insects would continue to become fewer in population as the drought increased, while the honeybee being cared for by man would decrease in population but little and would produce but little surplus honey. It was further supposed that with the return of increasing moisture, the native insects would increase in population and with them the amount of nectar produced by the honeybee would likewise increase. Up to May 15 the native insects were so meager that observations on many nectar plants in normal condition showed no insects save honeybees. With the beginning of rains in May the native insect population increased very rapidly but was unique in the number of deformed and dwarfed specimens which occurred. Up to the first of August many insects, especially butterflies, were collected and were all below normal for size. From that time on normal sized individuals appeared, and in October and November many hymenoptera which generally fly in May and June were captured. The supposition now is that with the present weather conditions, next year the honey plants and honeybees will be in normal condition but that the native insects will still be subnormal for population.

H. B. Parks.

Plant Survey of the State of Texas

The plant survey of this State which was undertaken in 1934 was added to by several expeditions during the present year, and results of

the observations made were collected and a manuscript entitled "A Catalogue of the Flora of the State of Texas" was submitted to the Director in September. This catalogue contains the technical and common names together with the location of five thousand species and forms.

H. B. Parks, V. L. Cory.

Miscellaneous

Due to the desirability of encouraging the growing of native plants which are useful to man and also the honeybee and to the demand for the information relative to such plants the following aid was rendered.

Upon the request of the Gonzales Palmetto State Park Board, V. L. Cory and the writer visited that area and prepared for them a list of the organisms which occur in that section. This list was printed by them.

Upon the solicitation of Mr. Elo Urbanovsky, Project Development Section, Rural Resettlement Division, that Division was furnished with maps showing the floral divisions of the state and with three detailed lists of native plants suitable to use in farmstead plats in three widely separated sections of the state.

Upon the solicitation of W. E. Connell of the Soil Conservation Service, a map of plant areas of the State together with a complete list of grasses and plants suitable for erosion control of the high plains area was furnished.

Due to the large number of requests for information relative to the uses of various plants coming to this office, in May the offer of Federal aid made to us for the compilation of such a list was thankfully received. This list entitled "An Annotated List of Plants Native to Texas Which Are Valuable to Agriculture" was compiled and the copies transmitted to the Director.

Upon the request of Dr. O. W. Park and Frank C. Pellett, Iowa Experiment Station, and at their expense, a trip was made to the Lower Rio Grande Valley in March. The object of this trip was a plant survey of the territory in which they were carrying out some experimental work in queen rearing. The survey of their territory was turned over to them. A complete log of the entire trip containing thirty-five hundred notations as to the exact location of plants was made and is on file in this office.

In April a trip was made from this Station to Balmorhea, Alpine, and the Chisos Mountains. The log of this trip contains over five thousand and plant references with exact location indicated by speedometer readings and road names.

Due to the insistence of the Big Thicket Association a trip was made to that place in September. In addition to the log of the trip which

contains about three thousand plant locations, a manuscript entitled "The Flora and Fauna of the Big Thicket" has been prepared and will be turned over to that organization and probably printed by them.

During the present year over one thousand plants have been identified at this office, most of them sent in by members of the Federated Women's Clubs which are interested in a garden project; 4-H Clubs; County Home Demonstration Agents; and County Agents.

During the present year the writer attended and presented a paper at a regional meeting of the Texas Academy of Science; spoke before and conducted field trips at the Science Field Meet at the Palmetto State Park; spoke in three different cities before Federated Women's Clubs; spoke before the San Antonio Scientific Society; attended the Short Course at College Station giving a paper on the pasture divisions of Texas and conducting the two day's meeting of the Texas Beekeepers Association; spoke at the field meet of the Big Thicket Association on the value of preservation of wild life and native flora stressing the value of beekeeping as it might be developed in that section; acted as the arrangements committee for the International Beekeepers Conference which met in San Antonio in November, with an attendance of over five hundred.

V. L. Cory cooperated in all of the activities which involved the determination of plants. H. B. Parks.

AGRICULTURAL ENGINEERING

Mechanical Harvesting of Cotton

The study began in 1927 in cooperation with the Division of Agronomy on the mechanical harvesting of cotton to determine the factors of efficiency, the effective cleaning of cotton, and the relation of the varietal characteristics as they affect mechanical harvesting of cotton was continued this year.

No changes were made in the stripper for 1936, but the Station bur extractor was rebuilt. The deflector board and spiked roll used in 1935 were removed and a reclaiming saw, partially inclosed with spring steel wire fingers, was installed.

In tests made October 14 on a number of varieties at College Station on cotton producing yields much below the average and where the plants had been partially defoliated by the leaf worm, the stripper harvested an average of 90 per cent of the cotton and the grades averaged one grade lower than those of hand-picked cotton. The bur extractor removed the burs, green bolls, and a good percentage of the green leaves.

In harvesting six varieties of cotton at Lubbock on November 12 the stripper harvested an average of 97.7 per cent of the cotton from the plants where the yield was a bale to the acre. Hand-picked cotton har-

vested on the same date graded middling, and the stripped cotton graded strict low middling, or one grade lower than the hand-picked cotton.

The breeding work to develop types of cotton better suited to mechanical harvesting than the commonly grown varieties was continued in 1936, both at College Station and at Lubbock. At College Station 26 special inbred selections of Ducona were harvested with the machine to test the effect of varietal characteristics on the harvesting qualities. A large number of hybrid and inbred lines of cotton were grown at Lubbock, and the more promising of these will be increased in 1937 and tested for their adaptability to mechanical harvesting.

Snapability of Cotton Bolls: A study was started in 1935 on the snapability of cotton bolls in relation to mechanical harvesting. Of the varieties tested this year the average pull required to snap bolls from the plants varied from 6.4. to 8.5 pounds per boll. It was found that in pulling the bolls from the plant slightly over 50 per cent were pulled off with the peduncle or with the stem attached.

H. P. Smith, D. T. Killough, D. L. Jones.

Factors of Efficiency in the Distribution and Placement of Cottonseed and Fertilizers

The cooperative study with the Bureau of Agricultural Engineering of the U. S. Department of Agriculture on the placement of fertilizers for cotton was discontinued in 1935, and a study was started to determine whether the difference in the germination of cottonseed when the fertilizer was placed near them was due to the fertilizer or to the disturbance of the soil.

Tests were planted with the fertilizer placed in bands 1.75 inches wide and one, two, and three inches below the seed and in bands two inches to each side of the seed and one, two, and three inches below the seed level. A test was also planted with all of the fertilizer placed on one side of the seed. For each test where fertilizer was distributed a check was planted where the soil was disturbed with the same equipment as that used when distributing the fertilizer.

When considering as a whole the tests with the placements below the seed, it appears that the fertilizer retarded the early germination of the cottonseed and also resulted in a lower total germination. The data show that where the soil was disturbed on checks below the seed, fewer seedlings emerged than where the soil was disturbed to the side of the seed and no fertilizer applied. This indicates that soil disturbance is a factor in the germination of cottonseed.

In the tests where the fertilizer was placed to the side and below the level of the seed there were significant increases at the first count over the checks in the number of seedlings that had emerged. The total emergence was also greater for all tests. At the second count there

was a slight fluctuation in the number of seedlings that had emerged on the different tests, both at College Station and at Nacogdoches. The results indicate that when the fertilizer is placed to the side and below the level of the seed, it has a stimulating effect on the germination of cottonseed, causing them to germinate more rapidly and giving a greater number of plants as a final stand.

At College Station the stand at harvest was not as uniform as at Nacogdoches. At College Station placing the fertilizer in a band two inches below the seed gave the highest yield per acre for the tests with the placements below the seed. At Nacogdoches the highest yield was obtained by placing the fertilizer three inches below the seed.

Placing the fertilizer two inches to each side and three inches below the level of the seed gave the highest yields per acre for the side placements at both College Station and Nacogdoches.

When considering yield per plant, the placement two inches to the side and two inches below the level of the seed was best at College Station, but at Nacogdoches the three-inch depth to the side of the seed was best. The yield per plant on the tests below the seed was best for the placement three inches below the seed at both locations.

Treatment of Cottonseed for Planting Purposes: A test was begun in 1936 to compare the effects of Ceresan, lime, and sulphur on the germination of sulphuric acid delinted and fuzzy undelinted seed. This test was conducted at both College Station and Nacogdoches.

Results at College Station showed that the treatment of undelinted fuzzy cottonseed with Ceresan and sulphur increased the number of seedlings emerging 13 and 9 per cent, respectively, when compared with untreated fuzzy seed. The use of lime gave a slight decrease in the number of seedlings emerging at Nacogdoches. Fuzzy seed treated with Ceresan gave an increase of 54 per cent, with lime an increase of 16 per cent, and with sulphur an increase of 37 per cent in the number of seedlings emerging.

Sulphuric acid delinted cottonseed were treated with Ceresan, lime, and sulphur at College Station and Nacogdoches. The sulphur treatment gave an increase of 17 per cent in the number of seedlings emerging, but lime gave a decrease of approximately 4 per cent. The Ceresan treated seed gave an increase of four seedlings at Nacogdoches and a decrease of two seedlings at College Station.

At College Station the acre yield of seed cotton for the untreated and the Ceresan, lime, and sulphur treated fuzzy seed was 441, 412, 491, and 447 pounds, respectively. At Nacogdoches the acre yield was 710, 684, 657, and 678 pounds, respectively.

The acre yields at College Station for the untreated delinted and the Ceresan, lime, and sulphur treated delinted seed was 409, 401, 348,

and 517, respectively. At Nacogdoches the acre yield was 689, 673, 700, and 609, respectively.

Planting of Cottonseed at Variable and Uniform Depths: Results obtained this year from planting cottonseed at variable and uniform depths did not show any significant differences in the yields.

The Use of Rubber Press Wheel: A test was begun this year at College Station and Lubbock to determine the effect of a small rubber-tired press wheel attached to the planter at a point where the wheel would roll and press the seed in the bottom of the furrow before they were covered. At College Station the use of this wheel gave more rapid germination of the seed and a greater total number of plants. Results at Lubbock will be found in the report of Substation No. 8.

Width of Furrow Openers: A test to determine the effect of the width of the furrow openers on the germination and stand of cotton plants was begun this year. No significant difference was secured in either the number of plants or the yield.

H. P. Smith.

Atmospheric Exposure of Wire and Fencing

This study, which is in cooperation with the American Society for Testing Materials, is one of eleven located in various regions of the United States. The objectives are: (1) To obtain useful engineering information concerning materials generally used for fencing or those that offer promise of economic suitability for use in fencing in the near future; and (2) to assist in setting up national standard specifications for fencing and barbed wire to afford consumers in various climatic regions an adequate guide in purchasing these materials.

The various samples included in this test were erected in December 1936.

H. P. Smith.

Garlic Drying

The Division of Agricultural Engineering and the Division of Plant Pathology and Physiology began a study this year of the causes of decay of garlic and methods of control. The Division of Agricultural Engineering designed and constructed a dryer at Moulton, Texas to determine to what extent artificial drying would control the decay of garlic.

Several thousand pounds of garlic was dried, some of which was badly infected from diseases before it was placed in the drier. It was found that when garlic was decayed to any extent before it was placed in the drier, drying did not arrest the decay sufficiently to enable it to be marketed. When sound garlic was placed in the drier, it was satisfactorily dried and decay prevented. It was also found that a temperature ranging from 120° to 130° gave the best results in the drying of

garlic. High temperatures had a tendency to cook the garlic, causing it to spoil quickly. When garlic was harvested green, it was difficult to dry. Well matured garlic, however, was dried successfully and only a small percentage decayed when it was stored in an open shed for six months.

Additional information on the diseases of garlic will be found in the report of the Division of Plant Pathology and Physiology.

J. J. Taubenhaus, H. P. Smith, G. E. Altstatt.

Prickly Pear Eradication

The study of prickly pear poison carried on jointly by the Division of Agricultural Engineering and Substation No. 14 at Sonora was continued in 1936. Even though the sprayer tanks used in spraying prickly pear have been lead lined, considerable trouble has been caused by rust particles that get in the small nozzle opening and stop the flow of the spray solution. Consequently a sprayer tank is being constructed with 18-8 stainless steel to determine whether this metal will withstand the corrosive action of the solutions used in poisoning prickly pear.

The results of poisoning tests this year will be found in the report from Substation No. 14.

W. H. Dameron, H. P. Smith.

Eradication of Mesquite Brush

Considerable data were collected during the year from ranchmen in various parts of Texas on the eradication of mesquite brush. Several ranches were visited where it was found that kerosene, when properly applied, would kill both the roots and tops. Four methods were used in applying the kerosene: (1) Spraying the entire circumference of the tree from the ground up for about 18 inches until the bark is thoroughly saturated; (2) pouring the kerosene on the tree through a small tube, thus saturating the bark a foot or more above the ground; (3) applying the kerosene with a rag mop by dipping it into a bucket of kerosene and dashing the saturated mop against the tree until the entire circumference is thoroughly wet; and (4) pouring kerosene on the stumps after the tree has been cut down. Results secured by ranchmen seem to indicate that the part of the tree from the ground up to about 18 inches and completely around the circumference should be thoroughly saturated with kerosene to secure good results. One ranchman recommended that a gallon of kerosene should be used on not more than 10 trees at average from 6 to 10 inches in diameter.

Two ranchmen were found who had purchased large Caterpillar tractors equipped with a tree-dozer to uproot the mesquite trees. This work appeared to be done at a cost averaging from \$1.25 to \$1.50 per acre.

on land where there were as many as 300 trees per acre. The machine cleared an average of one-fourth acre per hour.

It was the general opinion of most ranchmen that grubbing mesquite by hand labor was slow and expensive and there was danger that the mesquite roots would sprout.

H. P. Smith.

WILDLIFE RESEARCH

A division has been organized in the Station during the year for the purpose of conducting research in the field dealing with wild game with special reference to the conservation and increase of wildlife resources and the relation of these resources to agriculture in general. This work has been organized through a cooperative agreement with the Bureau of Biological Survey, United States Department of Agriculture, the American Wildlife Institute, the Texas Game, Fish, and Oyster Commission, and the School of Agriculture and Extension Service of the Agricultural and Mechanical College of Texas.

Several projects have been developed under the terms of this agreement, including a survey of the wildlife resources of Walker county, Texas; a study of Bobwhite quail in East Texas with special reference to the effect of the introduction of Mexican quail on the native quail; a study of plant-wildlife relationships, dealing largely with food and cover crops and wildlife aspects of cutover pine woodlands; a study of the gray and fox squirrels of East Texas; a study of the ecology of the Attwater prairie chicken; and a study of the present status and future needs of vanishing species of wild game.

This work has been initiated under limited facilities, but with the cooperation of all agencies, it should within a short time begin to yield up information and results of value in connection with the wildlife resources of the State.

Walter P. Taylor, Bur. Biol. Survey.

FEED CONTROL SERVICE

Inspection

The usual systematic inspection of feeding stuffs has been maintained during the past year, and seven inspectors have visited feed manufacturers, feed dealers, and a considerable number of consumers in order to secure official samples for analysis, weigh packages to prevent selling short-weights, and detect other possible violations of the provisions of the Texas feed law. Each inspector files at the office each week an itinerary which is subject to revision if considered advisable. In addition he is required to submit a daily report of his activities. During the period covered by this report the inspectors have traveled 93,675 miles in the performance of their official duties and visited 17,682 firms in

4,038 towns and cities. Several trips have been made from the office for the purpose of carrying on special investigations.

Computed from the sale of feed inspection tags, there were 1,210,790 tons of feed sold in the State during the year ended August 31, 1936, or 87,953 tons less than were sold during the previous year. This tonnage does not include hay, straw, and whole or unground grains or seeds, but only the amount of feeding stuffs regulated by the Texas feed law. Cooperation with the Food and Drug Administration of the U. S. Department of Agriculture has been continued and thus control exercised over interstate shipments of feed as further protection to Texas purchasers.

Samples

During the fiscal year the inspectors secured 3,379 official samples of feed, which were subjected to chemical analysis and microscopical examination. In addition to these, there were analyzed a few registration and special samples, making a total of 3,471 samples analyzed during this period. Fourteen samples of registered brands of vitamin D carriers were assayed for antirachitic potency.

Reports

The results of inspections and analyses are reported to the manufacturer, dealer and consumer as soon as practicable after the results are available. When a shipment appears to be adulterated or misbranded, the dealer is notified and advised to remove it from sale until the matter has been satisfactorily adjusted.

Shipments Withdrawn from Sale

During the year covered by this report dealers have been advised to remove from sale 573 shipments of feed, manufactured by 317 different firms, totaling 1,746 tons. These shipments were removed from sale because they did not meet the requirements of the law. Untagged shipments were properly labeled with tags furnished by the manufacturers; improperly labeled shipments were relabeled with official tags properly printed, or with tags showing guaranties that could be maintained, and in still other cases shipments were returned to the manufacturer. The sales of goods below guaranties were adjusted, in practically all instances, by manufacturers paying refunds to dealers and consumers when the deficiencies were sufficient to warrant such action. In all

cases where refunds were made to dealers, the dealers were advised to pro-rate the same to their customers, in so far as possible, so that the ultimate consumer would receive its benefit.

Violations

During the year five complaints were filed with county attorneys against manufacturers violating certain provisions of the Texas feed law. Three of these cases were settled by payment of fines and docket costs and two cases were dismissed on payment of fines and costs by the same defendant in two other cases. Two additional cases were tried before juries and the defendants were acquitted. Five hundred and seventy-two minor complaints were adjusted through correspondence from the office together with the assistance of the inspectors. These complaints consisted of untagged shipments of feed; improperly labeled shipments; incorrectly printed tags attached to packages of feed; short-weights, and other minor irregularities.

Seven firms were cited for hearings to be held in the office for the purpose of presenting evidence to show cause why they should not be prosecuted for violating the law. Five of these firms sent representatives to these hearings and two answered the citations by letters. Upon presentation of the evidence such action was taken as seemed advisable.

Hardness of Cottonseed Cake

In view of the fact that complaints are occasionally received by the Division of Feed Control Service that the cottonseed cake sold for feeding purposes is too hard for the animals to eat, it was considered advisable to devise a method of determining the hardness of cake and examine some of the cake upon the market. Eleven samples of cottonseed cake representing the output of eleven oil mills were tested and the crushing strength varied from 688.3-pounds, medium hard, to 2,570-pounds, very hard. None of the samples examined could be considered as representing soft cake. This work will be continued during the coming year.

Research Work on Commercial Feed

As the Texas feed law was enacted primarily to protect consumers of feed a certain amount of research work is necessary in order to secure scientific data upon which to properly administer the provisions of this law. Problems arise from time to time which require scientific investi-

gations, to protect the consumer against adulterated feed, to prevent the use of worthless and detrimental materials, to furnish adequate information, and to assist in deciding whether feeds are suitable for the purposes for which they are intended to be used.

The following Divisions of the Station have cooperated in research work during the past year: Chemistry, Dairy Husbandry, Poultry Husbandry, Range Animal Husbandry, and Swine Husbandry. These projects covered allowable hardness of cottonseed cake, value of rice and rice by-products as feeding stuffs, and vitamin and mineral requirements of live stock.

F. D. Fuller, James Sullivan.

PUBLICATIONS

During the fiscal year ending August 31, 1936, the Division of Publications edited and received for distribution sixteen bulletins and three circulars (one reprinted); the Director's Annual Report; various mimeographed progress reports of the several divisions; and four reports of the Division of Soil Survey which are published and distributed by the Bureau of Chemistry and Soils, but are listed among the station reports. The members of the station staff prepared and submitted to various technical journals and agricultural publications twenty-seven technical and eighty-six popular papers in the editing of which this division assisted. During a portion of the year the staff semi-monthly News Letter was prepared and published by the division and fifty-two press releases entitled "Press Bulletins" or "Progress Reports" were prepared and distributed to the press and to various agricultural workers including the Extension Service staff and the Smith-Hughes vocational teaching staff. Most of these releases were read over the Texas Quality Network.

The annual abstract circular prepared in this office, abstracts the bulletins, circulars and reports, as well as the scientific articles, and lists the popular articles, by members of the staff, published during the calendar year. Circular No. 78 for the year 1935 carries abstracts of bulletins 503-522, circulars 73-76, the Forty-Seventh Annual Report of the director, soil survey reports of Randall, Collin, Polk, Galveston counties, Texas. Twenty scientific articles by members of the staff are abstracted and twenty popular articles are listed. The circular also carries a list of the available publications for free distribution as of January 1, 1936.

The mailing list comprises 69,561. A total of 217,503 publications were distributed during the year, leaving on hand in the mailing room 798,181 copies available for free distribution.

The publications edited and distributed during the fiscal year 1935-36 are listed as follows:

Analysis of Publications Appearing from September 1, 1935, to Aug. 31, 1936

Bulletin	Title	Author	No. pages	No. copies
510	Seasonal Variations of Growth in Weight and Height of Texas School Children.....	Jessie Whitacre.....	72	6,000
511	Progress in the Study of the Mechanical Harvesting of Cotton.....	H. P. Smith, D. T. Killough, D. L. Jones, and M. H. Byrom.....	35	6,000
512	Trend of Taxes on Farm and Ranch Real Estate In Texas.....	L. P. Gabbard.....	21	6,000
513	The Relation of the Color and Carotene Content of Butter Fat to Its Vitamin A Potency.....	Ray Treichler, Mary Anna Grimes, and G. S. Fraps.....	34	6,000
514	The Vitamin A Requirements of Hens for Egg Production.....	R. M. Sherwood, G. S. Fraps.....	21	6,000
515	Availability of Nitrous Nitrogen to Plants.....	G. S. Fraps and A. J. Sterges.....	27	6,000
516	Effect of Age, Sex, and Fertility of Angora Goats on the Quality and Quantity of Mohair.....	J. M. Jones, B. L. Warwick, W. H. Dameron, and S. P. Davis.....	34	6,000
517	Commercial Fertilizers in 1934-35.....	G. S. Fraps and S. E. Asbury.....	43	7,000
518	Commercial Feeding Stuffs, from September 1, 1934 to August 31, 1935.....	F. D. Fuller and James Sullivan.....	182	8,500
519	Mescalbean (<i>Sophora Secundiflora</i>) Poisonous for Livestock.....	I. B. Boughton and W. T. Hardy.....	18	6,000
520	Base Exchange Properties of Some Typical Texas Soils.....	G. S. Fraps and J. F. Fudge.....	23	6,000
521	The Vitamin D Requirements of Chickens Grown in the Absence of Sunlight.....	J. R. Couch, G. S. Fraps, and R. M. Sherwood.....	31	6,000
522	Relation of the Occurrence of Cotton Root Rot to the Chemical Composition of Soils.....	G. S. Fraps and J. F. Fudge.....	21	6,000
523	The Hardness of Cottonseed Cake as Related to Its Suitability for Feeding.....	G. S. Fraps and C. D. Marrs.....	27	6,000
524	Fertilizer Experiments with Yellow Bermuda Onions in the Winter Garden Region of Texas.....	L. R. Hawthorn.....	35	6,000
525	Wheat Gray Shorts for the Prevention of Slipped Tendons in Battery Brooder Chicks.....	R. M. Sherwood and J. R. Couch.....	25	8,000
Circular 67	Citrus Orchard Management in the Lower Rio Grande Valley (Rev.).....	W. H. Friend.....	56	4,000
77	Control of the Cotton Flea Hopper.....	F. L. Thomas.....	8	7,000
78	Abstracts of Bulletins 503-522, Circulars 73-76, and Other Publications During 1935.....	A. D. Jackson.....	30	77,000
	Forty-seventh Annual Report.....	A. B. Conner.....	294	8,000

Soil Survey Reports Published During Year

Reports of soil surveys of Polk, Scurry, Hardeman, and Falls counties, Texas, published by the Bureau of Chemistry and Soils, U. S. Department of Agriculture, were received during the year.

Soil Survey of Polk County, Texas—H. M. Smith, Bureau of Chemistry and Soils, U. S. Department of Agriculture, in charge; and T. C. Reitch, Harvey Oakes, L. G. Ragsdale, and A. H. Bean of Texas Agricultural Experiment Station.

Soil Survey of Scurry County, Texas—E. H. Templin, in charge, and T. C. Reitch, Texas Agricultural Experiment Station.

Soil Survey of Hardeman County, Texas—E. H. Templin, Texas Agricultural Experiment Station, in charge; and T. W. Glassey, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Soil Survey of Falls County, Texas—M. W. Beck, Bureau of Chemistry and Soils, U. S. Department of Agriculture, in charge.

Technical Papers

During the year 29 scientific contributions by members of the staff appeared in the various journals as follows:

307. Three Junipers of Western Texas; V. L. Cory. *Rhodora*, 1936, Vol. 38.
313. The Fluctuation of Pig Weights; Fred Hale and C. B. Godbey. *Proceedings of the Association of Southern Agricultural Workers*, 1935, pp. 489-491.
316. Effect of Fertilizers on the Length of Cotton Fiber; E. B. Reynolds and R. H. Stansel. *Journal of the American Society of Agronomy*, 1935, Vol. 27, No. 5, pp. 408-411.
319. Review of Monograph on Genetics of Zea Mays, by Eyster; P. C. Mangelsdorf. *Journal of Heredity*, 1935, Vol. 26, pp. 241-242.
320. Comparative Anatomy of the Seeds of Cottons and Other Malvaceous Plants. I Malveae and Ureneae; R. G. Reeves. *American Journal of Botany*, 1936, Vol. 23, No. 4, pp. 291-296.
321. Comparative Anatomy of the Seeds of Cottons and Other Malvaceous Plants. II Hibisceae; R. G. Reeves. *American Journal of Botany*, 1936, Vol. 23, No. 6, pp. 394-405.
322. A New Columbine from the Edwards Plateau of Texas, V. L. Cory. *Rhodora*, 1936, Vol. 38, p. 75.
324. Chromosome Numbers in Relatives of Zea Mays L.; R. G. Reeves and P. C. Mangelsdorf. *The American Naturalist*, 1935, Vol. 69, pp. 633-35.
325. Chromosome Numbers in Sorghum; R. E. Karper and A. T. Chisholm. *American Journal of Botany*, 1936, Vol. 23, No. 5.
333. The Development of The Cotton Embryo; R. G. Reeves and J. O. Beasley. *Journal of Agricultural Research*, 1935, Vol. 51, No. 10, pp. 935-944.
334. Oak Poisoning in Range Cattle and Sheep; I. B. Boughton and W. T. Hardy. *Journal of American Veterinary Medical Association*, 1936, Vol. 89, N. S. Vol. 42, No. 2.

335. Cooperative Meat Investigations at the Texas Station; J. H. Knox and J. M. Jones. 13th Annual Report National Livestock and Meat Board, 1935-36, p. 77.
336. Separation of Cotton Root Rot Sclerotia from Soil Samples; C. H. Rogers. Journal of Agricultural Research, 1936, Vol. 52, No. 1, pp. 73-79.
337. The Toxicity of Broomweed (*Gutierrezia microcephala*) for Sheep, Cattle; and Goats; F. P. Mathews. Journal of the American Veterinary Medical Association, 1936, N. S. Vol. 41, No. 1, pp. 55-61.
338. Chromosome Behavior in Blackberry-Raspberry Hybrids; S. H. Yarnell. Journal of Agricultural Research, 1936, Vol. 52, No. 2, pp. 385-396.
340. A New Subjective Method of Testing Tenderness in Meat—The Paired Eating Method; Sylvia Cover. Food Research, 1936, Vol. 1, No. 3, pp. 287-295.
341. Effect of Pregnancy and Early Lactation on Wool and Mohair Production; J. M. Jones, B. L. Warwick, S. P. Davis. Proceedings of the American Society of Animal Production, 1936, pp. 150-153.
344. Further Studies of Earworm Damage in Sweet Corn Varieties in Texas; L. R. Hawthorn. Proceedings of the American Society for Horticultural Science, 1936, Vol. 33, pp. 505-507.
346. Diplodia Die-Back of Roses, Preliminary Report; J. J. Taubenhause and G. T. Boyd. The American Rose Annual, 1936, pp. 127-129.
347. Artificial Defoliation of Field-Grown Rose Plants, Preliminary Report; G. T. Boyd and J. J. Taubenhause. The American Rose Annual, 1936, pp. 130-131.
348. Principles of Genetics and Eugenics—A Review; B. L. Warwick. Journal of Heredity, 1936, Vol. 27, No. 2, pp. 84-86.
350. Floral Abnormalities in Sorghum; R. E. Karper and J. C. Stephens. The Journal of Heredity, 1936, Vol. 27, No. 5, pp. 183-194.
352. Vitamin A Requirements for Laying Hens; R. M. Sherwood and G. S. Fraps. Proceedings of 6th World's Poultry Congress, Berlin-Leipzig, 1936.
353. Longevity and Viability of Sorghum Seed; R. E. Karper and D. L. Jones. Journal of the American Society of Agronomy, 1936, Vol. 28, No. 4, pp. 330-331.

354. Relation of the Carotene Content of Certain Feed Materials to Their Vitamin A Potency; G. S. Fraps, Ray Treichler, and A. R. Kemmerer. *Journal of Agricultural Research*, 1936.
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SUBSTATION NO. 1, BEEVILLE

Substation No. 1, located in Bee County, five miles east of the town of Beeville, serves the interior Black Prairie Region, a large area of dark-colored, fertile soils, lying in South Texas. Goliad and Victoria soils predominate in this region. An average annual rainfall of 31 inches is fairly well distributed throughout the year. Mild temperatures, with few frosts, prevail, giving an average growing season of 288 days. All these factors combine to make this region admirably adapted to diversified farming with livestock as a base.

The chief concern of this station is the development of a profitable land utilization and soil conservation program adapted to this large area. Its activities consist chiefly of testing, developing, growing and curing of feed crops and grasses, along with their utilization through beef cattle, and the testing, developing, and growing of profitable cash crops with which to complete a balanced system of agriculture. Some attention is given to testing of trees and ornamentals for use in landscaping.

Feed Crops

Corn: The 2.71 inches above normal rainfall, which was fairly well distributed throughout the growing season, gave a good corn year. For the second consecutive year the entire area made an excellent corn crop. The Gulf storm on June 27 blew corn down and caused some weather damage but most of the corn was harvested in good condition.

Eighteen varieties were grown in the corn variety test. Golden June gave the highest yield with 47.6 bushels per acre. Golden Thomas came second with 46.4 bushels and was followed in turn by Stairs Yellow Surcrop, Mammoth Yellow Drouth Resister, Ferguson's Yellow Dent, and Reese's Drouth Resister.

Surcropper, Thomas, and Nicholson's Giant Yellow were planted in a date-of-planting test. These were planted February 20, March 1, March 14 and April 1. All varieties gave the highest yields on the third planting, followed closely by the second and first plantings in that order. April 1 plantings gave poor yields for all varieties. An eight-year average of this test gives very similar results to this year, there being little difference in the yields for the first three plantings and a considerable reduction for the late plantings.

In the corn breeding work, Golden Thomas, a yellow corn developed from white Thomas, has been produced with a uniform dark yellow color. Thirty-six bushels of State Registered seed are being distributed to farmers for further production of State Certified seed. This corn is outyielding its parent by more than 2 bushels per acre and is maintaining its desirable characters of firm, well-filled ears with good shuck covering to protect it from weevil and ear worm damage. It is being enthusiastically received throughout this section. Forty-nine pure line X Golden Thomas first-generation hybrids were grown in comparison with several of the standard varieties of corn. Some of these showed good yields but none was outstanding. Seventy-two pure line strains were crossed with Golden Thomas to produce hybrid strains for 1937 test.

Grain Sorghums: Sufficient moisture throughout the entire season produced a good spring crop of grain sorghum and a fair crop of second growth and fall-planted sorghum. Some midge damage was present in the second growth, and fall-planted sorghums were severely damaged by the cane borer. Excessive rains made harvesting difficult at times.

Twenty-two varieties were included in the grain sorghum variety test. Reed's kafir led in grain production with 59.8 bushels. Hegari came second with 59.4 bushels. These were followed by Red kafir, Darso, Sumac sorgo, Schrock kafir, and Chiltex in the order named. Honey Drip sorgo gave the highest yield of forage, followed closely by African millet and Sumac. When the average for a period of years is considered, Texas Blackhul kafir for early planting and Hegari for later planting continue to show the most satisfactory results. Extra Dwarf Yellow milo has given fair yields for very early planting to produce an early feed crop. African millet and Schrock continue to show promise for ensilage crops and are outstanding in resistance to bird damage.

Blackhul kafir, Hegari, and Dwarf Yellow milo were included in a date-of-planting test. Plantings began on March 5, and continued at 21-day intervals until four plantings were made. Kafir gave the highest forage yield from the March 5 planting and the highest grain yields

from March 26 planting. Hegari gave highest forage yields from May 7 planting and highest grain yields from March 5 planting. Milo also gave highest forage yields from last planting and highest grain yields from first planting. Because of sorghum midge none of the varieties produced seed on the May 7 planting. Accumulated data on this test indicate that, on an average, best results will be obtained from Kafir planted March 10 to March 25. Hegari should be planted around April 1 but may be planted throughout the summer. Milos give best results when planted around March 1.

The same three sorghums, representing the principal types grown in this area, were grown in a seeding rate test. Each variety was grown in 3-inch 6-inch, 12-inch and 18-inch spacings. Hegari gave the highest grain yields and highest forage yields from the 3-inch spacing, followed in turn by the 6-inch, 12-inch and 18-inch spacings. Blackhul kafir yielded the most grain from the 6-inch spacing, followed by the 3-inch, 12-inch and 18-inch in the order named. The 3-inch spacing gave the highest forage yield and was followed in order by the 6-inch, 12-inch, and 18-inch spacings. Milo gave the highest yields of both grain and forage from the 3-inch spacings. Both forage and grain yields decreased as the stand was thinned. These results coincide with an average of previous tests.

Small Grain: Twenty-one wheat selections and crosses and 21 oat selections and crosses were planted in nursery rows to test their resistance to rusts. Dry weather at heading time reduced yields to some extent but some selections gave fair yields. Check varieties of Nortex and other oats went down with leaf rust in February. Some of the selections showed remarkable resistance to leaf rust but were severely injured by stem rust. Other selections showed almost complete resistance to both rusts, and gave promise as rust-resistant oat strains for the Gulf Coast section. Wheat rusts did little damage to even the most susceptible strains, thereby eliminating the effectiveness of the rust-resistant test. The nursery was planted again in the fall of the year for further testing.

An increased planting of Victoria and Bond oats gave good results. Growing in the vicinity of common red-rust proof oats that went down with leaf rust in February these oats showed complete leaf rust resistance. Both varieties were attacked by stem rust but matured 20 to 25 bushels of oats per acre. Both these oats are being given more extensive tests with the belief that they will furnish a much longer period for grazing and give a fair yield of seed in most years.

Winter Legumes: Nineteen varieties of winter legumes were included in a variety test. Hubam clover, Yellow blossom annual, and bur clovers continued to show some promise of being of value. All others continued to show little possibilities for this section. Nitrogen inoculation of the seed at time of planting apparently increased yields about 10 per cent.

These legumes, planted in three-foot rows, gave better results than broadcast planting.

Summer Legumes: Cowpeas continued to give the best yields in a summer legume variety test which contained 15 varieties of legumes that grow through the warm part of the year. Brabham cowpeas led in yield, followed by New Era cowpeas, Guar, and Early Speckled Velvet beans. Sesbania, Mung bean, and Crotalaria made very light yields but 4 varieties of lespedeza again failed to make any yields.

A soybean variety test carried 11 southern varieties. Good growth was made early in the season. Excessive rains in late May and again in late June caused rust, and all varieties shed their leaves without maturing any seed. A date-of-planting test, beginning February 20 and planted at 10-day intervals until May 1, gave results similar to the variety test. Most plantings made good vegetative growth and some set seed pods, none of which was filled. Approximately 3000 acres were planted in the county on thirty or more farms. Most fields made a good vegetative growth but all were complete failures in seed production.

Nitrogen bacteria inoculation gave no increase in cowpea yields this season. The inoculation apparently increased vegetative growth to some extent on soybean plats but due to the weather conditions no weights were obtained.

Cash Crops

Cotton: Weather conditions during the early growing season were very favorable throughout this area. Excessive rains in late May and again in late June damaged the crop very severely and resulted in one of the lightest cotton crops the area has had in many years. Harvest season was good.

Eighteen varieties were included in the cotton variety test. Mebane 804-50, the selection that has been developed on this station, again led in yield with 409.5 pounds of lint per acre. Next was Oklahoma Triumph with 387.5 pounds, followed by New Boykin with 333 pounds. These were followed in yield by Missdel No. 5, Wacona, Startex, Qualla, Half and Half, Lankart and Lone Star.

Mebane 804-50 and Lankart 40, two varieties representing two of the leading types of cotton grown in this section, were included in a date-of-planting test. These were planted at 10-day intervals beginning February 20 and lasting till April. The highest yield of Mebane, 369 pounds of lint per acre, was produced by the February 20 planting. As the planting date was delayed the yield decreased gradually to the March 20 planting; thereafter it fell rapidly to 124 pounds per acre for the April 1 planting. Similar results came from the Lankart variety.

Beginning with 266 pounds for the early planting, gradual reduction extended to 188 pounds for the March 20 planting. April 1 planting gave only 57 pounds. The test has been run only two years but this year's results are almost identical with the 1935 results. Cotton breeding work was continued by further increasing and distributing Mebane 804-50 selection to farmers throughout this area. Several hundred acres were planted to it. In almost every instance it gave pleasing results by considerably outyielding other varieties. Further crossing and back-crossing Mebane 804-50 with Lankart for the purpose of improving the staple length, boll size and gin turnout, was done. Several F_1 and F_2 populations were grown and some promising selections made from these.

Broom Corn: Broom corn breeding work was continued by the formation of the South Texas State Certified Seed Growers for the purpose of producing State Certified seed. Three hundred pounds of State Registered seed were distributed to 5 growers in this organization from which about 2500 pounds of State Certified Texas Scarborough Dwarf broom corn seed were produced for distribution to growers in this section. Bagged head-to-row plantings were made to continue the supply of Registered seed for this organization.

Flax: For the second year flax was successfully grown as a winter crop in nursery rows. Six varieties were planted in late November and December. Abyssinian Yellow gave the highest yield of 12.5 bushels per acre. It was followed in turn by Rio 79, Punjab, B. Golden, Linota and Bison. No cold injury was experienced. The flax was harvested in early May. The two years' results indicate the possibility that flax may be profitably grown in this section as a winter cash crop. Somewhat increased plantings were made in the fall of 1936 and the test will be continued.

Vegetables: Cabbage fertilizer and variety tests were planted in October, 1935 and carried into 1936. Frost in January killed 90 per cent of the stand and the tests were abandoned. The tests were planted again in the fall of 1936. Onion variety and fertilizer tests were planted in November, 1935, and carried over into 1936. Cold destroyed stands in these also and the tests were abandoned. The fertilizer was planted again in the fall of 1936 and will be carried over.

Fruits and Ornamentals

Citrus: All citrus trees came through the 1935-1936 winter in good condition. Favorable weather throughout the summer caused a good crop to be set and carried through to maturity. One acre of satsumas produced about 100 bushels of fruit. Jaffa oranges made an excellent crop. Other round oranges produced some fruit. The grapefruit crop was light because of a late frost that killed many of the fruit buds.

Meyer lemons also were injured by the late frost and set only a part of a crop.

Deciduous Fruits: Practically all peaches, plums, and apricot trees died out during the summer. The lack of dormancy during the past few mild winters weakened them beyond the recovery point. Most of the grapes were killed by cotton root rot.

Rogers dewberry and Louisiana No. 2 dewberry made an excellent crop of fine fruit. McDonald, Lawton, and Dallas blackberries had a very unhealthy appearance and produced no fruit. Young dewberries made a light crop of excellent fruit.

Ornamentals. All Chinese Elms were killed by cotton root rot. Chinese Tallow trees continued to show promise as shade trees. Hackberry, Huisache, and Mesquite continue to be used extensively for shade trees. Tamarisk, California privet, and Amur River privet continue to be the leading hedge and screen plants. Native shrubs, including Agarita, Senisa, and Guajillo, continue to be used effectively in landscaping.

Beef Cattle

Forty-two head of yearling steers that were winter fed on roughages for 125 days, grazed on sudan for 175 days, and placed in feed lot for finishing, were carried from 1935 into February, 1936. These cattle were fed at a nice profit. Cotton seedcake supplement during the grazing period did not produce a profit on these cattle. The Sudan grass showed a high protein content throughout the season. Limestone apparently was not needed during the wintering period or grazing period for these cattle but was fed with profit in the finishing lot. Stomach-worm infestation made it desirable to drench the cattle twice with a solution of 1.75 per cent copper sulphate and 0.8 per cent nicotine sulphate, given at 10-day intervals. One cc. of this solution per pound live weight, per dose apparently was too strong for some individuals. Two died from its effect and several others were rather sick. One was killed from strangulation in drenching.

R. A. Hall.

SUBSTATION NO. 2, TYLER

Substation No. 2 is located ten miles northwest of Tyler and five miles southeast of Lindale, Smith county, on State Highway No. 37; latitude 32 degrees 28 minutes north and longitude 95 degrees 21 minutes west; elevation approximately 525 feet above sea level. The average annual rainfall for the past 32 years has been 42.76 inches. The average date of the last killing frost in the spring is March 16, and the first in the fall November 18. The station farm consists of

455.2 acres of land, of which approximately 170 acres are occupied by the East Texas Soil Conservation Experiment Station and operated by the Soil Conservation Service of the United States Department of Agriculture in cooperation with the Texas Station. The remaining area is utilized for pasture investigations, including the use of beef and dairy cattle, agronomic, and horticultural investigations. Part of the pasture land is also being used to obtain additional erosion and run-off data on pasture land. At the present time 35 acres are available for agronomic and horticultural crops, 150 acres are in cleared pasture, and approximately 95 acres are in woods of which 34 acres are pastured.

The soil is predominantly fine sandy loam of the Kirvin, Bowie, and Nacogdoches series, with smaller areas of other series. The topography is quite rolling, with slopes ranging from 3 to 20 per cent. There is a difference of 159 feet vertical elevation between the low and high points of the station.

The principal problems of this station deal with (1) the conservation and utilization of the upland soils, which, to a considerable extent, are depleted by cropping and erosion, (2) the production of various agronomic and horticultural crops, and (3) the protection of these crops from diseases.

Agronomic Investigations—Soil Fertility Studies

Cotton: Several years' work with commercial fertilizers for cotton have shown that all three of the usual fertilizer ingredients (nitrogen, phosphoric acid, and potash) can be profitably used, and that a narrow ratio between the nitrogen and phosphoric acid is desirable. The most profitable fertilizer for cotton, per acre, has been 400 pounds of 4-6-4, although 200 pounds has returned the greatest profit for money invested in fertilizer. Part of the results have been published in Bulletins 469 and 490.

Recent experiments on the value of Hairy vetch and oats as green manures have not shown these crops to have any advantage over the optimum commercial fertilizer application for the production of cotton.

Tests of the material known as Sulphur earth have shown this material to have had no value during the years 1935 and 1936. The two-year average production of lint cotton per acre has been: untreated, 249 pounds; sulphur earth, 260 pounds; 400 pounds of 4-6-4, 310 pounds.

Corn: Winter green manure crops for corn are not profitable in this section because of the necessity of turning them under in time for the early corn planting. The use of nitrogen alone at the rate of 20 to 24 pounds nitrogen per acre continues to be the most profitable fertilizer practice where corn follows a crop that has been liberally fertilized with a complete fertilizer. The use of sulphur earth under corn has decreased the yield, the average results for 1935 and 1936

being: untreated, 18.5 bushels; 150 pounds sulphur earth, 16.6 bushels; and 100 pounds sulphate of ammonia, 26.6 bushels shelled corn per acre.

Variety Tests

Cotton: The cotton variety test in 1936 consisted of seven varieties. The yields in pounds of lint cotton per acre were as follows: Rhynes Cook, 301 pounds; Half and Half, 270; Hi-Bred, 256; Mebane, 243; Mebane 804-50, 240; Lankart, 205; and Delpress No. 3, 165. The results over a period of years indicate the high yielding varieties to be Half and Half, Rhynes Cook, Hi-Bred, Mebane, New Boykin, and Lankart. Examination of a number of roots of the varieties grown this year disclosed a light attack of nematodes on all varieties except Rhynes Cook.

Corn: The dry soil conditions during June again cut the yield of the late maturing corn varieties, and added evidence to the conclusions previously reached that earliness is a very important factor in corn production. Surcropper led the 18 varieties in the test with 30.7 bushels per acre, and was followed by Giant Yellow with 29.7, Feguson's Yellow Dent with 29.0, and Red June with 28.7, while Hill's Yellow Dent and Hasting's Prolific were low with yields of 14.6 and 16.5 bushels per acre, respectively. Over a period of years, results very similar to those obtained this year may be expected.

Summer legumes: The New Era cowpea produced 2.20 tons of air-dry forage per acre to lead the seven cowpea varieties tested this year. Whippoorwill produced 1.98 tons; Brabham, 1.94 tons; and Groit, 1.83 tons; while the Chinese Red yielded 1.24 tons. *Crotalaria spectabilis* again produced the highest yield of any legume tested, 3.89 tons per acre, but is not suitable for forage since it is poisonous to livestock and must be utilized for green manure.

Soy bean varieties: A test of 26 varieties of soy beans for forage and seed did not indicate any superiority of this legume over cowpeas for forage production, while seed production was again practically a failure. The highest air-dry forage yields were obtained from varieties new to this section, T. S. No. 22828 being high with 1.95 tons per acre, followed by T. S. No. 22838, 1.79 tons; Delnoshat, 1.78 tons; and Delsta, 1.60 tons. The common forage beans, Laredo and O-Too-Tan produced 1.26 and 1.37 tons of hay per acre, respectively. The high yielding bean, T. S. No. 22828, is medium to coarse in stem and very susceptible to nematodes, while the second variety, T. S. No. 22838, is fine stemmed, semi-erect, and resistant to nematodes. Only four varieties were found to be free from nematodes: T. S. Nos. 22838 and 22837, Laredo, and Delsta.

Rate of planting soy beans: In a rate-of-planting test involving the large-seeded Mamloxi variety and the small-seeded Laredo, the highest

forage yields were obtained from a 50 pounds per acre seeding rate for the Mamloxi and 20 to 30 pounds for the Laredo. These beans were all grown in 36-inch rows. Seed yields were practically failures in this test also, but the higher seed yields were associated with the same seeding rates as the higher forage yields. Inoculation did not increase the yields.

Winter legumes: Hairy vetch failed to rank first in the winter legume test this year, being exceeded by Subterranean clover and *Angustifolia* vetch. Over a period of years, however, Hairy vetch has proved to be the most dependable winter legume, and has produced, on the average, approximately twice as much as any other sort. Applications of 150 pounds of superphosphate in the fall before seeding, continues to give large increases in yields.

Crop Improvement

Some work on two-crop improvement projects was done this year. There is a demand for a pure Gooseneck sorgo and the purification of this variety was begun. Cowpea breeding to produce a disease-resistant, fine-stemmed, high-yielding forage and seed cowpea was continued from last year; a number of crosses between the Chinese Red and Iron were made. Some preliminary crosses of the Iron on the edible cowpeas to introduce disease resistance into this valuable group were made in the fall, but the early killing frost destroyed the resulting seed.

Pasture Improvement

The work on pasture improvement consists largely of (1) mowing to control weeds and other undesirable growths, (2) practical methods of establishing improved pastures, and (3) tests of new pasture and forage plants.

The control of weeds and sprouts is the most important part of pasture improvement. It has been found possible to eradicate the common troublesome cypress or rosin weed (*Eupatorium compositifolium*) and sassafras sprouts by mowing and grazing. The persimmon sprouts are more persistent, partly because they are not palatable, but control is being slowly effected by mowing. The eradication of goat weeds (*Croton capitatus*) and bitter weeds (*Helenium tenuifolium*) is proving to be more difficult, especially in thin sod. Successful control of these weeds apparently includes the establishment of a thick sod.

The successful establishment of new sods of bermuda and other grasses, and the stimulation of thin sods has been greatly expedited by plowing. The use of barnyard manures in connection with plowing has given greater returns than an undisturbed surface application.

The testing of new grasses was continued in ungrazed test plats, and a few of the more promising grasses were subjected to grazing. Test plat performance of the Woolly-finger grasses (*Digitaria eriantha stolonifera* and *D. pentzii*) was very promising, but when subjected to grazing heretofore unnoted weaknesses became apparent. Cattle are quite fond of the grass, and when it is heavily grazed, they are able to prevent spreading by eating off the runners. Cattle also pull up the newly rooted plants. When grown in competition with other grasses the stolons are held off the ground and are thereby prevented from rooting. It appears that it will be necessary to protect these grasses until they are well established before they can be grazed to advantage. *Andropogon intermedius* did well in the test plats and fairly well under grazing. *Paspalum virgatum* also did well in the test plats, but was not grazed.

Mineral Requirements of Cattle

Hereford steers: Tests on the value of minerals added to the salt licks of beef cattle were continued. This year combinations of salt with bone meal and salt with lime, bone meal, and cotton seed meal were tested during the grazing season from April 1 to November 18. No beneficial effects of the added minerals could be noted. This is in accordance with the results obtained in 1934 and 1935, but contrary to those obtained in a feed lot test in the spring of 1933.

Jersey heifers: Six Jersey heifers, ranging in age from six to eight months at the beginning of the test, were used to compare a salt lick of two parts bone meal to one part salt with salt alone over a 213 day grazing period. The bone meal calves made a 25 per cent greater gain for the period than did the salt group, the actual average gains per head daily being 0.83 and 0.66 pounds, respectively.

P. R. Johnson.

Horticultural Investigations—Tree Fruits

The peach crop was good in spite of a late freeze. Ideal continued its record of consistently high yields and is to be recommended for East Texas. Up-to-date, another promising variety, dropped in production. Eagle's Beak again yielded a good crop, but because of its inferior fruit will be discontinued.

Diamond Jubilee nectarine again produced a good crop of desirable fruit. The Ansenne and Quetta varieties yielded very little fruit and are, apparently, not suited to East Texas conditions.

Production of the 10 Bruce plum trees dropped from an average of 1.7 in 1935 to .8 bushels in 1936. Abundance increased in production, whereas Burbank and Santa Rosa decreased.

Lawton Blackberries

Pruning: There was little difference in yield between the plots having old canes removed and new canes pruned to four feet, either after harvesting or in January. The average for 1935 and 1936 still shows a difference in yield in favor of pruning immediately after harvesting. Removing old canes but not pruning new ones decreased production. Mowing off all canes resulted in an almost total loss of plants.

Thinning: Five different methods of thinning plants were continued as in 1935. Leaving all new canes in a row one foot wide, followed by one new cane every 8 inches, one foot of new canes in every 4 feet of row, one new cane every 12 inches, and one new cane every 24 inches, was the order of treatments on the basis of production for 1936. For the two-year period, 1935 and 1936, one cane in 8 inches ranked first.

Fertilizer: The results of the second year of differential treatments in which 32 N-K-P combinations were used, seemed to show that potash and phosphorus are more important for blackberry production than nitrogen. Cotton seed meal as a nitrogen carrier is inferior to ammonium sulfate.

Roses

Understocks: Twenty-nine species, and species hybrids or rose varieties, are now under test in an effort to find a more satisfactory understock for rose budding than the Welch strain multiflora now used by nurserymen.

Thirty-seven different species crosses were made to develop new understocks. Nine crosses were successful and the seed has been stratified and planted. At present, 140 species of roses have been collected for use in this project.

Cultural: Preliminary experiments have shown that the time of application of a fertilizer to newly budded rose stocks is important. April applications of 600 pounds of 4-12-4 or 6-9-7 resulted in more dieback injury than later applications. July and August applications were only slightly more effective in promoting growth than the checks which received none. There seemed to be little advantage in applying the 600 pounds of fertilizer in 3 or 6 applications over a $\frac{3}{4}$ months period rather than all at once.

Defoliation increased dieback. Histological examination of treated material seemed to show that the abscission layer at the base of the peduncle is the important factor. The rapid formation of a heavy

abscission layer apparently prevents the dieback from going down the stem.

Storage and Harvesting: Undue exposure to dry air at the time of harvesting materially injures rose bushes. Plants subjected to moving air of 80° temperature and 18 per cent relative humidity for periods of time ranging from one-half hour to 32 hours, were injured in direct proportion to the time of exposure.

Plants were stored at 45° and at 28° to 32° in an effort to stop the further development of dieback, as well as to maintain the plants in a dormant condition for spring planting. Storage temperatures at the freezing point effectively prevented further development of dieback. Temperatures of 45° did not, even though plants were dusted with sulphur, sprayed with Bordeaux, or had the diseased portions of the cane removed with sterile shears. Plants stored at 45° did not remain dormant for the full 3-month period of storage. Plants stored in the 45° temperature with a relative humidity of 90 to 100 per cent were less subject to molds when the air was circulated with an electric fan.

Miscellaneous: Three varieties of roses were planted at two-week intervals from the 15th of November to the 15th of April to determine the most suitable time of planting. The results show that transplanting is successful anytime between November 15 and March 1 if plants are properly pruned and protected by hilling the soil about them.

Ten thousand soft wood cuttings were rooted and planted in April with less than 30 per cent mortality. The biggest loss was due to stem rot in the cutting bed and could be materially reduced by soil sterilization. Growers may use this method of propagation when the mortality on fall planted cuttings is high because of adverse weather.

Dormant cuttings of Welch strain multiflora were treated with phenylacetic acid and b-indole-3-propionic acid for periods varying from one-half hour to 32 hours and in concentrations of 1:500 to 1:100,000, to induce faster rooting. The results when compared to plain-water treatments were negative.

The effect of pruning of top and root on future growth of plants was tried on Radiance. Tops were pruned to 6, 12, 18 and 24 inches and roots to 6, 9 and 12 inches. The results show that under East Texas conditions, plants with about an 8 to 10-inch top and a 12-inch root suffered fewest losses and retained sufficient vigor to produce a maximum number of blooms during the following season.

J. C. Ratsek.

Entomological Work

Headquarters for entomological work were established at Substation No. 2, near Tyler, about the middle of April. The primary object in selecting this location was to make observations in connection with

cotton flea hopper activities for comparison with those of other sections of the State. Plans also called for observations on insects attacking crops other than cotton with the idea of eventually including in the research program such insects as those attacking fruit, vegetable, and ornamental crops. While most of the time was devoted to cotton flea hopper investigations, some observations were made on other insects.

Cotton Insects

In general, injury by flea hoppers, *Psallus seriatus*, in northeast Texas has been less than in the Blackland area of central Texas. Where farmers have grown cotton on both sandy and the heavier red soils during years when flea hopper damage was heaviest, they report much more damage on the red soils, even when both were on the same farm.

Infestation in 1936 was light in all fields. The greatest number of flea hoppers occurred in July, but there was a sharp decrease thereafter, due to the hot, dry weather. The peak of infestation averaged 13 flea hoppers per 100 plants on 22 farms. The largest number of adult flea hoppers in stands of croton weeds was found during the first week of September, when an average of 1904 insects per 100 sweeps was collected on five farms.

W. L. Owen, Jr.

Boll weevils in scattering numbers occurred early in the season, but only a few injurious infestations developed. Later in the season weevils were scarce.

W. L. Owen, Jr.

The cotton bollworm, *Heliothis obsoleta*, was present throughout the season, but did little damage except in bottom land fields.

W. L. Owen, Jr.

Rose Insects

Rose fields were visited at intervals through the season to check upon possible insect damage to the crop. At certain points there were quite a few larvae of the corn ear-worm, *Heliothis obsoleta* (Fabr.) feeding on the buds and flowers. These infestations were spotted and did not cause much damage. Early in May the common flower thrips, *Frankliniella tritici* (Morgan), became so abundant on roses that the buds had the appearance of being burned at the tips before they had begun to open. While some varieties suffered worse than others, all varieties were affected. At this time practically all buds were unfit for cut flower sales.

Open blooms left in the fields furnished excellent and abundant breeding places for the thrips and were sources from which the insects spread. The flower opens in two days after the bud has reached the point where thrips cause damage.

During May and June, several insecticides including two arsenical sprays, a pyrethrum-sulphur dust mixture, and a nicotine sulphate spray, were applied in preliminary tests to control thrips. The arsenate of lead and Paris green sprays were the only materials which reduced the infestation at all; the percentage of control, however, was small.

During the period of these tests, the flowers contained from 26 to 34 thrips each. The number dropped off suddenly the last of June so that there were less than 10 thrips per flower.

W. L. Owen, Jr.

Peach Tree Insects

With rather heavy planting of peach trees during the last two years there has been a demand for information on methods of controlling the peach tree borer on young trees. Most growers are familiar with the paradichloro-benzene crystals method of treating older trees, but have not had experience with methods recently recommended for the treatment of young trees. In order to be able to furnish information based upon experience, a series of experiments using four treatments has been started in the orchard of the Substation.

W. L. Owen, Jr.

Soil and Water Conservation Investigations

(In cooperation with the Soil Conservation Service
U. S. Department of Agriculture)

Research work in soil erosion and water conservation is being conducted at this Station by the Soil Conservation Service in cooperation with the Texas Agricultural Experiment Station. The principal work of the Tyler Soil Conservation Experiment Station is the measuring of run-off and soil losses from fields and plots under different conditions. The effects of such factors as vegetative cover, degree of slope, length of slope, arrangement of crops, cultural practices, and size and shape of area are being measured and studied. This information on the amounts, causes, and means of controlling soil and water losses forms a basis for the development of practical methods of conserving soil and water in this region.

The experiments are located on Kirvin, Nacogdoches, and Bowie fine sandy loam soils on slopes varying from 4 per cent to 16½ per cent. Kirvin is a rather poor and very erodible soil. Nacogdoches is a more productive and less erodible type. Bowie, found on gentler slopes, is generally less erodible than the Kirvin but erodes severely when saturated.

In 1936, losses were measured from 33 plots, 22 terraces, and three natural watersheds. These areas range from 1/200 of an acre to 7.94

acres. Tanks which catch all of the run-off are installed at 21 plots. Divisors which take out a fraction of the total run-off are used on the remaining 12 plots.

Each of the 22 terraces and 3 watersheds is equipped with a Parshall flume and a liquid level recorder to measure the rates and volumes of run-off, and a Ramser silt sampler to measure the total soil loss. Soil and run-off losses are measured from a strip-cropped area, a gullied area, a wooded area, a pasture terrace, 4 strip-cropped terraces, and 17 terraces entirely in row crops.

Cropping Plans: While obtaining information on soil and water losses, an effort is being made to build up the fertility of the soil. With this in view, a 3-year cropping plan for areas not strip cropped has been put into practice on the station farm with very good results. This plan consists of cotton, corn, and cowpeas, with a winter cover crop of hairy vetch preceding the cotton and a winter cover crop of oats preceding the corn and cowpeas.

The plowing under of one crop of cowpea vines, two crops of oats, and one crop of hairy vetch within a period of 3 years should improve the fertility of the soil. The only commercial fertilizers now being used consist of 180 pounds of 18 per cent superphosphate applied at the time the vetch is planted and 75 pounds of ammonium sulphate applied as a side dressing to the corn.

In an effort to furnish continuous protection on strip-cropped land, a distinct rotation is applied to the erodible strips, and another rotation is applied to the resistant strips. Under this plan, the strips are in a fixed location. Corn and cotton are the summer crops on the erodible strips, with a winter cover crop of oats preceding the corn, and a winter cover crop of vetch preceding the cotton.

On the resistant or control strips, three crops are grown in a 2-year period. A winter cover crop of vetch is followed by sorghum in the summer. The sorghum is harvested, and the stubble remains until oats are planted in the spring. The crop arrangement in this plan permits the staggering of the danger periods during which time the land is broken and unprotected.

Oats are planted on erodible strips in early fall. About a month after this, hairy vetch is planted on the control strips. At this stage, oats should offer a certain amount of protection while the vetch is becoming established. In the spring, oats on the erodible strips are plowed under as a green manure crop and corn is planted. At this danger period, vetch on the control strips gives excellent protection to the soil. In early summer, the vetch is plowed under and sorghum is planted. The protection offered by the corn at this period is not great. However, by this time, the heavy spring rains are over. The

summer sorghum is harvested and the stubble remains through the winter. This stubble gives sufficient protection while the cornland is plowed and seeded to vetch. The vetch continues to grow until cotton-planting time in the spring. In early spring, the sorghum stubble is disked and oats are planted. During this period, the fall-planted vetch on the erodible strips offers good protection. This entire treatment is repeated every 2 years.

Rainfall: April, May, and December are months of heaviest rainfall, while June and August are often periods of drought. The spring and fall rains are generally of long duration and moderate intensities. Those of the summer are often short and torrential in character.

The 5-inch rain of May 8-10, 1936 occurred at a time when much of the land was unprotected. The high intensity of this rain, together with the exposed condition of the soil, caused soil losses far in excess of previous annual losses. During this 5-inch rain, 1.60 inches fell in 14 minutes, and 1.08 inches fell in 5 minutes. Such a 5-minute intensity is expected to occur only once in 100 years.

Strip Cropping: The planting of erosion-resistant crops in contour strips alternately with strips of row crops has been practiced at this station for a period of years and has permitted very low soil losses. The action of effective control strips under smooth slope conditions is generally that of reducing erosion on the areas so occupied and of retarding the flow of run-off water resulting in sedimentation in or above the control strips.

Two plots, one check and one strip-cropped, each 20 feet wide and 145 feet long on Bowie fine sandy loam soil on $5\frac{1}{2}$ per cent slope gave the following losses for the period of January 1, 1935 to August 1, 1936: the check plot lost 61.9 tons of soil per acre and 22.7 per cent of the rain, while the strip-cropped plot lost 20.4 tons of soil per acre and 24.7 per cent of the rain. During this period, the 5.06-inch rain on May 8-10 caused a soil loss of 36.9 tons of soil per acre from the check plot and 2.4 tons of soil per acre from the plot which had a good stand of winter oats on its 36-foot control strips. The 36-foot erodible strips were planted to cotton only a few days before the rain.

A comparison of these results indicates that under the proper conditions, strip-cropping is a very effective method of reducing soil losses. It remains to be determined, however, just how far it is safe to go in recommending this practice.

Woodlands: A 7.94-acre wooded area had a $3\frac{1}{2}$ -year average soil loss of 0.059 ton of soil per acre. It lost 3.8 per cent of the rainfall and had up to 1936 a maximum rate of run-off of 0.26 inches per hour.

On Kirvin soil with $12\frac{1}{2}$ per cent slope, an unburned area lost 0.55 per cent of the total rainfall and 0.383 ton of soil per acre during the 5-year period 1932-1936, while the plot burned over once each year had a soil loss 4 times as great and a water loss 7 times as great. Continued burning is proving to be a bad practice. It gradually destroys the absorptive and protective leaf and leafmold covering and tends to increase both soil and water losses.

Grasslands: In 6 years of measurement, a 1/100-acre Bermuda grass plot lost only 14.2 pounds of soil and 1.2 per cent of the rainfall. Ten of these 14.2 pounds were lost during the first year.

A pasture terrace on badly-eroded steep Kirvin with a thin vegetative cover lost in $3\frac{1}{2}$ years 0.666 ton of soil per acre and 6.8 per cent of the rainfall.

Plants for Erosion Control: Additional perennial crops which give long periods of protection to croplands are needed for better erosion control. Dense-growing crops furnish varying degrees of protection, depending upon the period of occupancy of the land, type of growth, and culture. Two of the most promising crops for erosion control are Lespedeza sericea and hairy vetch. Sericea, a summer perennial, in addition to providing protection against erosion, looks promising as a hay and pasture crop. Hairy vetch is the outstanding winter legume for field use and is being used in rotations both as a soil-conserving and soil-improving crop.

The two most promising grasses at this station are Woolly-finger and St. Lucie. Woolly-finger is a drought-resistant grass and does well even on thin soils. It spreads rapidly and is palatable to livestock in both green and cured stages. The fact that it does not produce viable seed and has to be propagated by sets or runners somewhat limits its use. St. Lucie is a rapidly spreading grass resembling Bermuda but is without underground root stocks.

Balk Water-Furrow Strip-Cropped Plan: This plan, designed to increase the erosion resistance of erodible cropland without the use of terraces, is a combination of several methods of control which have permitted low soil losses. In its present status, half of the slope length is occupied by permanent control strips of Lespedeza sericea. Alternate narrow strips of tilled land are further protected by annual fall seeding of hairy vetch, a small portion of which remains standing in the spring in a succession of contour balks between the sericea strips. Water-furrows are plowed out following the planting of the balks in June so that any ponded run-off in excess of infiltration capacity may be absorbed or drained into protective waterways.

During the rain of May 8-10 when the sericea strips were well-established, the BWS plot on $9\frac{3}{4}$ per cent slope lost only 77 pounds of soil and 27.7 per cent of the rain, while the check plot lost 1,942

pounds of soil and 41.9 per cent of the rain. These results show that excellent protection and low run-off losses can be obtained through the use of perennial crops in narrow strips at close intervals. They also indicate that water-furrows and perennial strips might be used in a modified form on a field scale to conserve moisture during periods of moisture deficiencies.

Effect of Slope Length: On $8\frac{3}{4}$ per cent slope on Kirvin fine sandy loam soil, a plot 36 feet long lost 77 tons of soil per acre; a plot 72 feet long lost 111 tons per acre; a plot 145 feet long lost 199 tons per acre; a plot 72 feet long, whose topsoil was stripped and subsoil exposed, lost 313 tons of soil per acre during the 5-year period 1931-1935. These results show that, for this soil, erosion losses increase rapidly as the length of slope is increased; that when the surface soil is removed, erosion losses are accelerated as the depth of topsoil decreases.

Terraces: By using suitable terraces, soil losses can be greatly reduced. This is true even though the soil losses as measured at the terrace outlet are not a true measure of the erosion taking place on that terrace interval, since much of the soil moved from the upper part of the interval is deposited in or just above the terrace channel. In 1935, an unterraced field lost 73.7 tons of soil per acre, while a 700-foot level terrace on similar soil lost 7.3 tons. A plot whose length is about equal to the slope length of this terrace interval showed a loss of 35.9 tons of soil per acre in 1935.

Short (700-foot) graded terraces and long (1,700-foot) graded terraces with different vertical spacings give lower soil and run-off losses as the spacings decrease.

Terraces 1,700 feet long gave lower run-off losses and higher soil losses than did the 1,100- or 700-foot terraces. The 5-year averages were 7.4 tons of soil per acre and 5.9 tons of soil per acre for the 1,700-foot and 700-foot terraces, respectively. The maximum rates of run-off to 1936 were 1.97, 2.37, and 2.87 inches per hour for the 1,700-foot, 1,100-foot, and 700-foot terraces, respectively, indicating lower peak rates for the longer areas.

Results from short (700-foot) terraces with different grades show conclusively that soil loss, run-off losses, and peak rates of run-off are decreased as the grade in the channel is decreased. Level terraces open at one end are giving lowest losses. The average annual soil losses were 5.4 tons per acre and 14.3 tons per acre, and the run-off losses were 19.5 per cent and 37.3 per cent for the level and 6-inch terraces, respectively. The maximum rates of run-off were 1.55 inches per hour for the level terrace, and 3.85 inches per hour for the terrace with the 6-inch grade.

A long (2,300-foot) level terrace gave soil loss, run-off losses, and rates of run-off lower than any other terrace under measurement. This

terrace, however, because of its length and grade, suffers occasional crop damage due to poor channel drainage. This occasional damage is offset to a certain extent by the saving of soil and water, especially during periods of moisture deficiencies. However, long, level terraces are not recommended as a general practice because of the difficulty encountered in maintaining ridges strong enough and high enough to prevent heavy rains from breaking them.

S. J. Mech and J. B. Pope, S. C. S.

SUBSTATION NO. 3, ANGLETON

Substation No. 3 is located 3.1 miles northeast of Angleton, Brazoria County, adjacent to the St. L. B. & M. Railroad and to State Highway No. 58. The latitude is 29 degrees north and the longitude 95 degrees west with an elevation of 23 feet above sea level. The average annual rainfall over a period of 23 years was 46.19 inches. The maximum temperature for the same period of time was 105 degrees F. and the minimum temperature for the same period of time was 10 degrees F. The average relative humidity for a period of 22 years was 79.9 per cent and the annual evaporation for the same period of time was 44.79 inches. The mean monthly wind movement for a period of 23 years was 3640 miles. The average date of first killing frost in the fall is December 1 and of the last killing frost in the spring is February 26, giving an average growing season of 278 days.

The growing season of 1936 was characterized by alternating periods of heavy rainfall and periods of drying weather. The months of May and July had a total rainfall of 9.43 and 8.11 inches respectively while the month of June had a total rainfall of .56 inches. The total rainfall for the year was .13 inches below normal. The extremes in precipitation were very injurious to crops in general and the yields this year were far below normal. The stand on some plats of cotton was lost during the May rains and due to a dry June replanting could not be successfully completed until the rains in July started, which was too late for cotton to make a crop in this section. Some of the test plats were replanted to cotton in June with fair stands resulting. Other cotton plats and some corn plats were replanted to cowpeas for soil improvement or to Schrock Kafir for a late feed crop. A dry fall was favorable for harvesting operations and fall plowing. There were no injurious winter temperatures during 1936.

Cotton: Eighteen varieties were grown in the cotton-variety test in 1936 with six replications of each variety. Extreme fluctuations in the rainfall during the growing season, together with a heavy infestation of the cotton flea hopper, boll worm, leaf worm, and boll weevil, resulted in a low yield. The bolls were smaller than usual and a large percentage failed to open due to excessive summer rain with the

accompanying boll rot. The stands were fair to poor. D. P. L. 11A made the highest average yield with 345 pounds of lint cotton per acre, followed in order by Acala with 295 pounds per acre, Half and Half with 282 pounds per acre, Delfos 6102-531A with 278 pounds per acre, Mebane 804-50 with 275 pounds per acre, and Stoneville 5 with 274 pounds per acre. Qualla made the lowest yield, which was probably partly due to the poor stand, only 37 per cent of a stand. All varieties had a length of lint of 15/16 inches or more with the exception of Half and Half which had a length of lint of only 13/16 inches. Since 1925, the varieties making the highest comparable yield are D. P. L. 4-8 with 482 pounds of lint per acre, Stoneville No. 1 with 382 pounds per acre, D. P. L. 11 with 381 pounds per acre, Day's Silvermine with 374 pounds per acre, Russell with 362 pounds per acre, Half and Half with 360 pounds per acre, and D. P. L. 10, Missdel No. 2, and Delfos 6102-911 all with over 350 pounds of lint cotton per acre. The Delfos types of cotton are high yielders in this section, and while the bolls are comparatively small and the per cent of lint somewhat low, they have an excellent length of staple, are early, and make good yields.

Further selections were made in the cotton breeding work from strains obtained from the Mebane 804 variety. The inbreeding work was continued to study the effect of inbreeding as compared with straight plant selection on the uniformity and yield of cotton. A number of promising plant selections were obtained from this work in 1935 and were grown in plant rows in 1936. The unfavorable spring weather conditions resulted in a very poor stand, and while the seed were increased, the yield data are of little value.

The backcrosses of hybrid Mebane strains of cotton to obtain a higher lint percentage on good yielding strains were continued in 1936.

Corn: Eighteen varieties of corn were grown in a variety test in 1936. The stand was fair on all plats. The heavy May and July rainfall severely injured the corn in this test and the resulting yields were low. White Tuxpan made the highest average yield with 12.4 bushels per acre followed by Surcropper with 12.3 bushels, Hastings' Prolific with 11.4 bushels, Reese's Drouth Resister with 10.9 bushels, and Dwarf Mexican June and Golden June each with 10.5 bushels per acre. Of all the commercial varieties tested in the past 18 years, Mexican June, Red June, Reese's Drouth Resister, Surcropper, White Tuxpan, Brazos White, Hastings' Prolific, Yellow Tuxpan, and Golden June have made the highest comparable yields with from 23.2 bushels down to 20.0 bushels per acre in the order named. All of these varieties are adapted to this section and can be recommended. The Yellow Tuxpan and Golden June are yellow varieties developed by the Texas Experiment Station and are the recommended yellow varieties

for this section. Seed of Yellow Tuxpan were distributed in 1935 and there are two State Certified seed growers of this variety.

Good progress was made in 1936 on the development of a yellow, sweet Tuxpan and pure seed were obtained in a small quantity. The seed should be available for distribution in two more years.

A number of inbred lines of Surcropper and Mosshart Yellow Dent were crossed with Tuxpan and Hastings' Prolific in 1935 and the hybrids were grown for yield data in 1936. The yields were low, but as a whole, the Tuxpan and Surcropper hybrids appeared promising.

In a comparison of corn and Schrock kafir for grain yield, the average yield of Tuxpan corn was 7.1 bushels per acre as compared with 15.9 bushels for Schrock kafir. The eight-year average yield of Tuxpan was 16.3 bushels and that of Schrock Kafir was 21.7 bushels.

Forage yields of corn and sorghum varieties: A poor stand of all sorghum varieties was obtained this year and repeated replanting was necessary. The crops were late and the final stands were poor. Schrock kafir made the highest yield and also had the best stand this year. Mammoth Russian Sunflower, also grown in this test, had a good stand at the first planting, but made a poor yield, with 1.31 tons of air dry forage per acre. For the past three years Orange has made the highest yield of air dry forage with 3.91 tons per acre in three cuttings each year as compared with 3.40 tons for Schrock kafir and 3.37 tons for Red Top, each with two cuttings. Red Top made a higher yield than Schrock kafir the first two years of the test when it had good stands. Tuxpan corn made an average of 1.30 tons per acre in this test.

Wheat and Oats Rust Nursery: A wheat and oats nursery planting of rust-resistant strains was made in Brazoria, Matagorda, Calhoun, Victoria, Jackson, Wharton, Fort Bend, Harris and Galveston counties in November, 1935, from seed furnished by the Division of Agronomy from the rust-resistant strains obtained in the breeding work with these crops. A number of the nursery plantings were not harvested due to damage from livestock, birds, or rodents. Of the wheat strains harvested, an average yield of 17.7 bushels per acre was obtained in the Victoria planting, 10.3 bushels in the Jackson planting, 9.1 bushels in the Wharton planting, and 7.6 bushels in the Matagorda planting. One strain of wheat made a yield of 26.5 bushels at Victoria. In the oats nursery planting on the station, all varieties averaged 40.6 bushels per acre, with six strains making a yield of over 50 bushels per acre. Data over a period of several years will have to be obtained on these and other strains of oats and wheat to determine their adaptability and value in this part of the State, but their resistance to rust appears to be good and the outlook excellent for adapted strains.

Flax: Six varieties of flax were planted in each of the wheat and oats nursery plantings. This is the second year flax has been planted

as a winter crop in this section. In the winter of 1934-1935 a severe freeze killed the planting on the station. The average yield of all six varieties of flax ranged from 10.8 bushels per acre at Victoria to 5.2 bushels in Calhoun county. Rio 79 was the highest yielder of the varieties tested, making 22.2 bushels per acre in Jackson county and 21.8 bushels per acre in Victoria county.

Permanent pasture: The same seven head of steers on the 17.5 acres of improved pasture and the seven head placed on the unimproved pasture in 1934 are still being carried in 1936. The steers on the improved pasture remain in better condition throughout the winter than the steers on the native unimproved pasture. The steers on the native pasture make rapid gains in the spring and early summer and fatten more quickly than those on the improved pasture, but from the first of July until the following spring they appear to lose flesh, although probably making some growth. The steers on the improved pasture fatten more slowly in the spring but continue to gain until late fall and are then in a much better condition of flesh than the steers on the native pasture ever get during the year. All three seasons have given the same results in this regard. The steers on the improved pasture are much heavier than those on the native pasture, but no weights have been obtained since no scales are available. The improved pasture consists largely of Bermuda, Carpet and Dallis grasses with common lespedeza and some White Dutch clover. The native pasture is largely composed of little bluestem, *Andropogon scoparius*, with some big bluestem, bushy bluestem, and salt grass and various weeds. The native pasture is not mowed but the improved pasture is mowed twice each year. Mowing is recommended as the best and most economical method of controlling weeds in pastures in the Gulf Coast.

Summer legumes: In the variety test of the summer legumes, sesbania made the highest yield of air dry forage in 1936 with 2.72 tons per acre as compared with 1.56 tons for Early Speckled velvet beans, 1.34 tons for *Crotalaria spectabilis*, and 1.27 tons for *Crotalaria intermedia*. The soybeans made yields of less than one ton per acre in the variety test in 1936. The heavy rainfall in May and July injured the soybeans. For the five years tested, sesbania has made an average yield of 2.48 tons of air dry material per acre as compared with 2.07 tons for *Crotalaria spectabilis*, 2.00 tons for O-Too-Tan soybeans, and 1.63 tons for Laredo soybeans.

A variety and date of seeding test with 18 varieties of soybeans was carried in 1936. The early planting was made on April 27, the medium planting on May 19, and the late planting on June 5th. These planting dates were about one month later than planned but could not be made sooner due to unfavorable weather conditions. Laredo made the highest average yield of air dry forage at all three planting dates with 1.31, 1.05 and .96 tons per acre respectively for the early, medium, and late plantings. There was a slight reduction in yield for most varieties

comparing the medium date of planting with the early planting and a great reduction in yield at the late planting. There was very little consistent differences in seed yields between the three dates of planting. Virginia made the highest average yield with 121 pounds per acre at the early date of planting, 166 pounds per acre at the medium date of planting, and 177 pounds at the late date of planting. This is in contrast with Manchú, the variety making the second highest average yield, with 169 pounds, 157 pounds, and 103 pounds per acre respectively for the early, medium, and late plantings. All the seed yields were low and the quality was poor.

In addition to the above varieties, forty-four new strains of soybeans were received from the U. S. Department of Agriculture and were planted in single row plats. F. P. I. No. 89075 made the highest yield of air dry forage with 2.37 tons per acre, followed in order by F. P. I. No. 71660 with 1.93 tons per acre and F. P. I. No. 71650 with 1.91 tons. The highest yield of seed was made by F. P. I. No. 85523 with 561 pounds per acre, followed by F. P. I. No. 85356 with 418 pounds per acre and F. P. I. No. 71660 with 387 pounds per acre. Some of these varieties are promising and should be tested further. Seed was saved of all the varieties that produced a good quality of seed.

In a soybean inoculation and rate of seeding test with the Laredo variety, the inoculated plats made an average yield of .60 tons of air dry forage per acre and 70 pounds of seed per acre, as compared with .66 tons and 78 pounds for the plats not inoculated. Where 20 pounds, 30 pounds, 40 pounds and 50 pounds of seed per acre were sown, the increased rates resulted in an increase in the number of plants per plat, but had very little effect on the forage yield, producing average yields of .57 tons, .66 tons, .57 tons and .72 tons per acre respectively. The average seed yields for the above rates of seeding were 85 pounds, 76 pounds, 63 pounds and 70 pounds per acre respectively.

Winter Legumes and Grasses: Clovers, vetches, and winter peas were grown in a variety test in the winter of 1935-1936. A mild winter was favorable for the winter legumes and grasses, and the yields were for the most part above the average. Hubam clover made the highest yield of air dry forage with 2.52 tons per acre, followed in order by White Dutch clover, Subterranean clover, Alsike clover, and Hop clover with yields of 1.58 tons, 1.56 tons, 1.55 tons, and 1.52 tons per acre, respectively. The winter peas were destroyed by insect pests early in the winter. The highest yield of vetch was .90 tons made by Purple vetch. Of the three grasses grown, Italian Rye grass made a yield of 4.00 tons of air dry forage per acre as compared with 1.24 tons for Rescue grass and .78 tons for Dallis grass. These grasses made an excellent growth this season.

For the past five years, Hairy vetch has made the highest average yield with 1.67 tons of air dry forage per acre followed by Hubam

clover with 1.59 tons, Subterranean clover with 1.49 tons, White Dutch clover with 1.45 tons and Red clover with 1.36 tons per acre. Italian Rye grass has made an average yield of 1.66 tons per acre as compared with .70 tons for Rescue grass.

Fertilizers: The Gulf Coast prairie soils respond to fertilizer applications. The chief need of these soils is phosphoric acid, and nitrogenous fertilizers are profitable when used in connection with phosphoric fertilizers. Potash has been of little value on these soils. The main fertilizer test on this station consists of six acres in a three-year rotation of corn, cotton, and cotton. Each fertilizer treatment, except the checks, appears twice in the corn and four times in the cotton. An application of 400 pounds of 4-12-4 per acre is used as a check and appears on every sixth or seventh plat. The nitrogen, phosphoric acid, and potash are varied independently from the 4-12-4 formula, and the applications range from 200 to 1000 pounds per acre. In addition an 0-4-0 and an 0-8-0 formula are used at the rate of 400 pounds per acre. Ammonium sulphate, 20 per cent superphosphate, and muriate of potash are used in making up the different formulas and all are mixed on the station.

The cotton in this test was planted in 1936 and a good stand was obtained. The May rains, together with a heavy growth of grass on the heavily fertilized plats, destroyed the stand on most plats. Replanting was not possible during a dry June and the land in this test was replanted to cowpeas in July and they were turned under for soil improvement in the fall. The results in previous years appear in the Forty-eighth Annual Report.

In a potash test with cotton where a blanket application of 400 pounds per acre of a 4-12-4 formula is made and where in addition 250 pounds and 500 pounds per acre of Muriate of potash is used, the increased potash gave yields of 222 pounds and 232 pounds of lint cotton per acre, respectively, as compared with 234 pounds where no additional potash was used. This test was replanted in June this year. In the four-year average there has been little consistent difference between the potash plats and the checks. However, the increased amounts of potash have not been profitable and had little effect on the yield.

The corn in the regular fertilizer test had a good stand in 1936 but the wet weather severely injured the plants and the yield was low. The yields were erratic and no conclusions can be drawn from this year's results. In the six years data have been obtained, two years' results are the same as this year, the different fertilizer treatments having little effect on the yield due to unfavorable climatic conditions. In the other four years phosphates and nitrogen were beneficial, and increased applications resulted in increased yields. It is doubtful, however, if the increases have been profitable.

A source of nitrogen test with corn was conducted in 1936. Cyanamid, ammonium sulphate, and nitrate of soda were used in a 400-pound per acre application of an 8-12-0 fertilizer formula. Their respective yields were 9.85 bushels, 9.10 bushels, and 10.19 bushels as compared with 7.17 bushels where an 0-12-0 fertilizer was applied at the same rate. Adverse climatic conditions affected the corn in this test.

A pasture fertilizer test was conducted in 1936. The fertilizers were applied April 23 on the surface of a sod composed largely of carpet grass. There were four plats of each treatment. A rainy period in May, when the pasture plats were flooded for several days, may have affected the results in this test. Monthly cuttings were made from May through October, with a lawn mower. The treatments used, expressed in pounds of available Nitrogen or Phosphoric acid per acre, were 0-40-0, 0-80-0, 20-40-0, 40-80-0, 40-40-0 and no treatment, and the respective yields obtained were 2609 pounds, 2608 pounds, 2787 pounds, 2849 pounds, 2818 pounds, and 2596 pounds of air dry forage per acre. The treatments resulted in little increases in yield this season.

In order to determine the effect of phosphoric acid applied to the surface of the land in a native hay meadow composed largely of Andropogons, an application of 40 pounds per acre of available phosphoric acid was applied on April 24th. Two cuttings were made, the first on June 22 and the second on October 19. The fertilized plats averaged 6231 pounds of air dry hay per acre as compared with 6825 pounds for the plats receiving no fertilizer.

Time and method of seed bed preparation test: This project was started in 1932. The land is prepared in the fall or spring, or both, and is either bedded or flat-broke, or both. All combinations are used and cotton and corn are grown in a three-year rotation, each method of preparation appearing once for corn and twice for cotton. In 1936 on the corn plats the spring bedding gave the highest yield, followed in order by fall flat breaking and by spring flat breaking. On the cotton plats, replanted in June, spring flat breaking gave the highest yield, followed in order by fall flat breaking and by fall bedding and spring rebedding. For the four-year average there appears to be little difference in any of the methods used for cotton or corn. The thorough preparation of the seed bed given in all cases appears to be sufficient. Under average farming conditions, bedding only has resulted in many cases of a poisoning of the land with grasses and weeds, mainly bermuda grass, since this method never completely stirs the soil in any one season, and these plants continue to grow.

Effect of green manure crop on cotton and corn: This test was started in 1934 when Sesbania was planted on one-half acre and plowed under in the fall. Cotton was planted on the other half-acre that year. In

1935 a plat of cotton and one of corn was grown on each half-acre and the same was true in 1936, although the cotton and corn plats on each half acre were switched. In 1935 the corn yielded 18 bushels per acre after the green manure crop as compared with 13 bushels after the cotton. In 1936 the yields were 7.5 bushels and 6.6 bushels respectively, indicating there was some residual effect of the green manure crop in the second year. There was a difference of 32 pounds of lint cotton per acre in favor of the green manure in 1935 but in 1936 the green manure plat yielded 7 pounds less than the plat with no green manure. The average yield for the two years was 278 pounds of lint cotton on the green manure plat and 265 pounds on the plat without a green manure.

Horticultural Work

Figs: A number of new varieties of figs were obtained in 1936 and approximately one and one-half acres were added to the variety planting. The fig trees made a good growth in 1936 and some fruit production from the variety orchard can be expected in 1937. A number of figs were pollinated in the summer from pollen produced by a caprifig tree on the station and a large amount of fertile seed was obtained. A number of fig seedlings emerged in 1936 from the seed planted in the spring of 1935. These and other seedlings to be grown will be used in the fig breeding project.

Blackberry and Dewberry variety test: In 1936 the McDonald blackberry produced the highest yield with 19,058 pints per acre, followed in order by Haupt with 18,679 pints, Dallas with 10,469 pints, Selection No. 2 with 7954 pints and Advance with 6236 pints. Youngberry made a yield of 5922 pints per acre. For the three-year average, Haupt leads with 20,566 pints per acre followed by McDonald with 20,005 pints, Selection No. 2 with 9819 pints, and Dallas with 8626 pints. The Youngberry variety averaged 3070 pints per acre. Rogers, Austin Mays, and Lawton produced low yields. The McDonald produced a high yield of good quality berries that are easily picked and is the best variety tested at this station. It should be planted with Haupt since it is not self-fertile. The Youngberry variety produces an excellent quality of berry but the yield has been low.

Citrus: A number of new cold-resistant types of satumas to replace those lost in the freeze in 1935 were received during the summer and were set out in a nursery row. No fruit were produced by the citrus on the station in 1936.

Grapes: Lomanto made the highest yield of grapes in 1936 with 14,422 pounds per acre, followed by Chesselas fountainbleau with 9393 pounds and Champanel with 5282 pounds. The Carman variety had the best quality of grapes from the standpoint of the juice or eating.

Plums: A good crop of plums was produced in 1936. Excelsior, Bruce, and Methley produced the highest yields this year, with Texas

Beauty and Nona producing fruit for the first time. For the past six years Excelsior and Bruce have produced the highest yield with an average of 12.0 and 9.2 pounds of fruit per tree respectively. These varieties are probably the best for this section. The Excelsior is a small cooking plum and the Bruce is a large, showy and fairly good eating plum.

Pecans: A few nuts were produced in the pecan variety orchard in 1936. The Schley variety produced the highest yield, followed by Curtis and the native seedling trees. For the six years these trees have produced nuts, the Curtis and Schley have made the highest yields, but all yields were low. The Stewart variety has produced very few nuts.

R. H. Stansel.

Fig Products Investigations

Experiments were made to develop a substandard pack of canned Magnolia figs. The best sample from the standpoint of appearance, texture, and flavor was prepared from lye-peeled figs which were kettle cooked with water for 5 minutes, canned hot, sealed and processed at 212°F. for 60 minutes. The lye-peeled figs also made the most attractive pack but the unpeeled, stemmed, and blanched figs canned in water had the best flavor. Samples which were pressure-cooked within sealed cans at 240°F. for 30 minutes usually had a slight caramelized flavor. The presence of the stems on the fruit detracted from the flavor.

A series of spiced fig samples were made in which the spice formula was kept constant and the method of preparation was varied. The best sample with regard to all factors under consideration was prepared from lye peeled figs, but the samples which had the best flavor were prepared from either stemmed and unpeeled or unstemmed and unpeeled figs which had been given a short dip in a boiling 2 per cent sodium bicarbonate solution. The unstemmed, unpeeled, and undipped sample was lacking in flavor.

The use of ordinary commercial brown sugar in varying proportions with cane sugar and of various grades of soft sugars alone detracted from the quality of fig preserves by masking the flavor of the figs.

Further work on fig conserves was done this year to improve the formula. The per cent by weight of the various ingredients was established. Control of the flavor was obtained by varying the per cent by weight of the oranges and figs. Conserves which had been canned for over a year were found to contain no rancid flavor from the citrus oils and the pecan nut meats were not objectionably soft.

Preliminary experiments were made to develop a beverage from figs. None of the samples were better than fair in appearance. The sample which was best in flavor was made by sieving ripe figs which had been blanched in boiling water, adding an equal weight of 10 per cent sugar solution to the sieved material, canning and sterilizing. The juice of

Magnolia figs was obtained by means of a fruit press after various pretreatments such as peeling and blanching. To some portions sugar, and sugar and acid were added and some portions of the juice were untreated. All samples were filtered, bottled, and pasteurized. Most of the juice samples were good in appearance but none of them had a good flavor.

Two products were developed from crushed figs. The first was a ground fig preserve and the second a jelly center made from crushed figs, sugar, glucose, pectin, and acid which can be used in candy making. Further improvements in coloring and in flavor were made on Marischino and Mint type figs from figs which had been kept in a sulfurous acid holding solution.

Comparisons were made between figs both stack-dried and dehydrated after treatment with burning sulfur, and after treatment with pure SO_2 gas mixed with air to give a 6 per cent concentration. No essential differences could be found in the quality of the final products which were sulfured by the two methods and the amount of absorption of sulfur dioxide by the figs was about the same by both methods. The application of SO_2 gas under the conditions of this experiment was more difficult than that of burning sulfur. From the standpoint of appearance, texture, and flavor, the stack-dried samples were better than the dehydrated samples but one of the latter had the best flavor. In the grade-out tests the stack-dried samples had the highest percentages of No. 1, or excellent, and No. 3, or cull figs, and the dehydrated samples had the highest percentage of No. 2, or fair to good figs. The factor which placed most of the dehydrated figs in the No. 2 grade was that of color. The cost of producing stack-dried figs was much higher in 1936 than it was in 1934. Most of the difference was due to poorer quality figs in 1936 which resulted in a higher drying ratio.

Ground figs, to which 6 per cent by weight of sugar was added, sealed in tin cans and frozen at 0°F . were better than any other sample with higher or lower percentages of added sugar. As was true in previous experiments, hand-peeled figs in sirup in sealed containers were better than those in unsealed containers and the use of small amounts of sulfur dioxide or acid retarded the rate of deterioration of the frozen samples in unsealed containers. The frozen samples deteriorated from an average of good in quality to fair during 14 months of storage at 0°F .

Experiments on fig sirup were continued this year. When the sirup was made by extracting the figs with repeated changes of hot water and concentrating the extract under vacuum, no fig flavor remained in the final product. Sirups which retained some of the fig flavor were made by building up the water extract from the figs to the desired density by the addition of sugar or by cooking the figs with a sugar solution and draining off the sirup when the desired density was reached.

A study was made of methods of treatment to prolong the keeping time of fresh figs for shipping purposes. Figs held in fruit baskets at

an average temperature of 80°F. kept one day. When the temperature was reduced to 49°F., another portion of the same lot of figs kept 7 days. Exposure of the figs to a 3 per cent mixture of sulfur dioxide gas with air increased the keeping time at 80°F. to 1.7 days and at 49°F. to 9.1 days. In another set of experiments, figs which were packed in a single layer and held at 86°F. required 3 days for complete spoilage, and 3.7 days when packed in a single layer with individual separators. At 60°F. single layers without separators required 14.7 days, and with separators 18 days for complete spoilage. The indications from these observations are that with proper packing, refrigeration, and possibly the use of mild dosages of sulfur dioxide, the spoilage loss of Magnolia figs during shipment can be considerably reduced.

H. M. Reed.

SUBSTATION NO. 4, BEAUMONT

Substation No. 4 is located six miles west of Beaumont on the Houston road at latitude 30 degrees north, and longitude 94 degrees west. Elevation is 26 to 30 feet above sea level. The station comprises 100 acres of land consisting largely of Lake Charles and Crowley clays, which are representative soils of the region. The average annual precipitation from 1914 to 1936, inclusive, was 53.71 inches. As a rule the precipitation is distributed fairly well during the year. The precipitation was only 48.48 inches during 1936, and was very low during the months of March and June. The average length of the frost-free period is 269 days, but it was only 260 in 1936.

Rice Investigations

(In Cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture)

Variety Tests of Rice: Sixteen varieties of rice were grown in replicated 1/50th acre plots in 1936. Rexoro was the highest yielding variety in the test with an average yield of 2,201 pounds per acre, followed by Acadia, Shoemed, and Caloro in the order named. For the six-year period, 1931-1936, the four highest yielding varieties were Rexoro, Fortuna, Acadia, and Caloro in the order named.

The advanced nursery yield test consisted of 89 varieties and selections grown in replicated 3-row, 16-foot plots. A total of 169 strains was grown in triplicated 5-row, 9-foot plots and 169 strains in single 3-row, 16-foot plots. A large number of hybrid selections of short, medium, and long-grain types and of early, midseason, and late maturity was included in the three yield nurseries. Of particular promise were a number of early and midseason maturing long-grain selections from the cross Edith x Fortuna.

Hybridization: The space-sown hybrid nursery grown in 1936 contained 1,261 hybrid selections from 53 different crosses varying from

F₃ to F₈ generations. Of considerable promise was a large group of selections from the crosses Rexoro by Delitus, by Fortuna, and by Supreme Blue Rose. Early maturing long-slender-grain selections made from these crosses appear to have the desirable plant characteristics of the Rexoro variety as well as desirable grain characters. The F₂ populations of 19 varietal improvement crosses were also grown in 1936. Sixty-five hybrid selections from F₅, F₇, and F₈ generations were harvested for the purpose of advancing to a nursery yield test in 1937. Many panicle selections were made and will be grown in space-sown rows in 1937.

Eighty-six F₁ plants involving 21 crosses were also grown in 1936. Many of these crosses involve disease-resistant varieties, particularly varieties resistant to leaf diseases.

Bulked hybrid populations of 26 crosses were grown in 1936. Of these, 14 were F₃ generations of crosses between Indian Patna and our commercial rice varieties.

Natural Crossing Study: Pairs of glutinous and common varieties of similar maturity were space sown in rows 1, 2, and 3 feet apart. The amount of natural crossing was determined from the percentage of common starchy kernels occurring in the glutinous varieties. This study has been conducted for the six-year period 1931-1936, inclusive. The extent of natural crossing varied from .03 to 1.89 per cent in 1936.

Border Effect on Field and Nursery Plots: Border effect studies have been conducted for the 5-year period, 1932-1936. The individual rows of each plot were harvested separately on several varieties in the field plot variety test and the advanced nursery test. The field plot studies have shown little varietal difference with respect to increased yield of border rows over center rows. No consistent increases or decreases of border rows over center rows have been recorded in nursery plots.

Nursery Plot Technic Study: Four varieties sown at four rates of seeding and four-row spacings were grown in a randomized block experiment in 1936. This test was also conducted in 1934 and 1935.

Rice Storage Experiments: The use of various chemicals as a means of controlling stored grain insect pests and for improving keeping qualities of rough rice is being conducted in cooperation with the Bureau of Entomology and Plant Quarantine.

Rice Disease Investigations: A rather large number of varieties and hybrid selections was grown in nursery plots for the purpose of recording their reaction to various diseases. The most resistant types will be tested further in 1937. Many of the most resistant strains in the test consisted of hybrid selections.

Rice Variety Date of Seeding Test: Six varieties were used in this test during 1936. Plantings were made, as in preceding years, at 20-day intervals from March 20 to June 10. Early Prolific and Latex were the

earliest maturing varieties regardless of the date of planting. Approximately 120 days were required for these varieties to mature when planted March 20, and 104 days when planted June 10. Texas Fortuna, Nira, and Blue Rose were later in maturing and ranked in the order named. Rexoro was the latest in maturing in each case. The first planting required 167 days and the last planting 139 days to reach maturity. The largest yields of grain of all varieties, excepting Blue Rose, were obtained from the planting made April 10. The heaviest yield of Blue Rose was produced by the seeding made March 20. The later plantings resulted in lighter yields of grain in all cases.

Rice Rate of Seeding: Blue Rose rice was seeded at the rates of 60, 80, 100, 120, and 140 pounds per acre. The land was kept free from weeds. The yields ranged from 2025 pounds of rough rice for the 60-pound seeding to 2294 pounds for the 120-pound rate. The 140-pound seeding produced only 2100 pounds. There was not a very great difference in the yields regardless of the rate of seeding. This lack of a greater difference in yields may be partly due to the lack of weeds and grass which permitted the rice plants to tiller more freely where the stands were not very thick.

Rice Rotations: The smallest yield was obtained from the plats that have been cropped to rice continuously. This treatment produced 938 pounds of grain as compared to 2200 pounds for the rotations of rice and idle land, and the rice and cotton. Except for the plats cropped to rice each season, there was not any great difference in yields obtained from the different rotations in this test.

Weed Control with Acid Solutions: Solutions of sulphuric acid were used for spraying plats of rice to determine the amount of injury to the rice plants and weeds. The solutions were made up by weight to five, ten, and fifteen per cent of acid. These were used when the rice plants were approximately one, two, and three weeks old. The rice plants were not injured by a five per cent solution and weeds showed but very little injury. The stronger solutions killed all of the weeds and injured the rice plants to some extent. However, the rice plants recovered and made very satisfactory growth. The yields of grain were increased from approximately 6 to 35 per cent. The largest increase was obtained from the use of a 15 per cent solution applied when the plants were approximately three weeks old. This work gives promise of being of value in controlling weeds in the rice fields of this region.

Rice Fertilizer Test: The results obtained from the large field plats were very similar to those of preceding years in that sulphate of ammonia used alone gave the largest increases in yield of grain. The largest increase of approximately 39 per cent was obtained from the use of 200 pounds of sulphate of ammonia per acre applied approximately 30 days after the plants emerged. Practically all plats receiving superphosphate contained a large amount of grass. The use of superphosphate at the time of planting resulted in a more rank growth of grass

than on the applications made at a later date. However, in all cases superphosphate failed to increase the yield of grain, which was probably partly due to the growth of grass.

Cooperative Rice Fertilizer Test: A test using ten fertilizer treatments and a no-treatment in six replications was conducted on a farm near Nome. The results were not very satisfactory, partly due to the large number of weeds present. The largest increase in yield, 14 per cent, was obtained from the use of 24 pounds of nitrogen and 48 pounds of phosphorus per acre. This was obtained from a 11-48-0 built up with sulphate of ammonia to give the above. Nitrogen alone gave but 5 per cent increase in yield, and phosphorus alone did not increase the yield any. A similar test was conducted on some of the lighter soil at this station. The results were somewhat irregular, but the largest increase, approximately 30 per cent, was obtained from the use of 24 pounds of nitrogen supplied by sulphate of ammonia.

Methods of Applying Fertilizers to Rice: A treatment of 100 pounds of sulphate of ammonia and 150 pounds of superphosphate was applied to rice by placing the fertilizer on top of the soil, and by placing it with the seed. Applying the fertilizer on top of the soil increased the yield of grain 13.13 per cent. Where the fertilizer was placed with the seed the yield was increased 28.26 per cent. This test was conducted with six replications, and without an exception an increase in yield was obtained from applying the fertilizer on top of the soil, and an additional increase was obtained where the fertilizer was placed with the seed.

Fertilizers Applied to Rice without Dividing Levees: The results obtained in this work indicate very little if any lateral movement of fertilizers applied to rice even though the irrigation water is applied in a short time. The fertilizers were applied on top of the soil. In the case of applications made approximately 30 days after the plants emerged, the fertilizer was applied one afternoon and the water applied the following morning. Yet the yields indicate that the fertilizer did not move as far as the adjoining row, which was 8 inches away.

Sources of Nitrogen and Phosphorus for Rice: Sulphate of ammonia, nitrate of soda, and Cyanamid were applied to rice at rates to supply 24 pounds of nitrogen per acre. Regular 20 per cent superphosphate, granular 32 per cent superphosphate, and raw bone meal were applied at rates to furnish 24 pounds of phosphorus per acre. The use of phosphorus increased the yield from 5.4 per cent to 6.6 per cent with the granular superphosphate giving the greatest increase. The use of nitrogen did not increase the yield, but the use of Cyanamid decreased the yield by injuring the germination of the seed. However, the results were rather irregular, which was attributed to variation in the soil and heavy rains shortly after planting.

Effects of Fertilizers on Germination of Rice Seed: Sulphate of ammonia and Cyanamid were applied in the drill with the rice seed at rates

to furnish 12, 24, and 36 pounds of nitrogen per acre. Another test was used in which superphosphate was added to the above in amounts to furnish an equal amount of phosphorus. Heavy rains at the time the seed were germinating injured the test, but the results indicated no injury from the use of sulphate of ammonia at any of these rates. Cyanamid injured the germination in all cases with the heavy rates giving germination that was approximately 50 per cent of that obtained where no fertilizers were used. The addition of superphosphate appeared to have no additional effect on the seed.

Cylinder Experiments with Fertilizers on Rice: In the test conducted, as a check on the field tests, for the fourth consecutive year phosphorus gave much greater increases in yield of both straw and grain than was obtained from nitrogen. The use of superphosphate at the rate of 150 pounds per acre increased both straw and grain approximately 58 per cent. Sulphate of ammonia used at the rate of 200 pounds per acre increased the straw 7.38 per cent and the grain 8.30 per cent. The use of a complete fertilizer containing phosphorus, nitrogen, and potash increased the straw and grain 66.42 and 65.14 per cent, respectively. The fact that these results do not agree with those obtained from the field plats may be partly due to the lack of weeds and grass in these cylinders.

The results obtained in the test of sulphate of ammonia and ammoniated peat as sources of nitrogen, and superphosphate and raw bone meal as sources of phosphorus, were very similar to those obtained in the other cylinder tests. No noticeable increase was obtained from either nitrogenous fertilizers, but both phosphatic fertilizers increased the yields. The use of superphosphate at the rate of 300 pounds per acre increased the straw yield 39.90 per cent and the grain 19.96 per cent. These yields were somewhat larger than was obtained from bone meal. However the yields in all of the cylinders are decreasing each year. Cylinders that were filled with soil at the beginning of the test but not planted until 1936 produced 49.42 per cent more straw and 50.00 per cent more grain than the other untreated cylinders that had been planted each season. R. H. Wyche and H. M. Beachell, Bur. Pl. Ind.

Field Crop Investigations

Cotton Varieties: The yields were fairly good in this test in 1936. The lightest yield, produced by Harper, was 202 pounds of lint per acre. D.P.L. 11 produced 436 pounds of lint per acre, which was the largest yield recorded. Mebane 804-50 was second with 344 pounds, and Sunshine third with a yield of 308 pounds of lint per acre. All the other varieties produced less than 300 pounds of lint per acre each. A part of an adjoining acre is badly infested with cotton wilt. This was planted to these varieties and counts were made on the number of dead plants. There was a noticeable difference. Wild's Semi-Wilt Resistant showed but 2 dead plants as compared to 86 by Half and Half.

Corn Varieties: Heavy rains during May injured all varieties in this test. Reese Drouth Resister produced the largest yield, which was only 20.5 bushels of shelled corn per acre. Synthetic Surcrotter No. 2 and White Tuxpan were next with yields of 18.7 and 17.5 bushels per acre, respectively. Improved Golden Dent and Jarvis Golden Prolific produced 11.7 bushels each, which was the lowest yield obtained.

Wheat and Oat Varieties: None of these varieties suffered any injury from winter killing, but the heavy rains in May, just prior to time for harvesting, flooded them to a depth of approximately 14 inches for about 36 hours. The loss of grain was heavier on the oats than with the wheat. The yields of wheat varied from 3.7 to 13.8 bushels per acre. The oats produced yields of from 6.00 to 27.8 bushels per acre.

Flax Varieties: A flax nursery was planted, and very little cold injury was observed. However the heavy May rains injured the test very noticeably, especially where wheat or oats were planted in combination with the flax. The seed yields varied from 1.7 to 9.55 bushels per acre. The variety A. Yellow produced the largest yield of 9.55 bushels per acre.

Forage and Pasture Crop Investigations

Winter Legumes: Subterranean clover produced the largest yield of 35,681 pounds of green forage per acre. Hubam and Alsike clovers produced 24,469 and 24,807 pounds per acre. All other varieties produced less than 20,000 pounds per acre each. Subterranean, Alsike, and Hubam produced the largest yields of air-dry forage which were 10,776, 8,756, and 5,872 pounds per acre, respectively. Some increases were obtained from inoculating the seed, but these increases were not very large.

Summer Legumes: The rains during May were very bad on this test, and quite a few plats were killed out from flooding. These rains resulted in very irregular stands on many plats. Sesbania suffered practically no injury as this crop withstands excessive flooding very well. Sesbania and Mammoth Yellow soy beans produced the largest yields of both green and air-dry forage. However the yields of the latter were based on but one plat as compared to three on the former. These varieties produced approximately 6 tons of green and 1.9 tons of air-dry forage per acre each.

Pasture Fertilization: The individual plat yields were somewhat irregular this season, but the average results show some very noticeable increases from several treatments. The greatest responses were obtained from a combination of nitrogen and phosphorus applied on limed pasture. The use of 80 pounds of sulphate of ammonia and 160 pounds of superphosphate per acre increased the yield of air-dry forage 153.77 per cent over the area that received no lime or fertilizer, and 78.33 per cent over the limed area that received no fertilizer. In every case the limed plats

produced greater yields than were obtained from similar treatments made on unlimed plats. The use of lime alone increased the yield of air-dry forage 42.30 per cent, which was greater than the increase obtained from either sulphate of ammonia or nitrate of soda used alone. The results this season show some very valuable returns can be obtained from liming and fertilizing pastures in this region.

Horticultural Crops Investigations

Nematode Control Work: The fertilizer treatments were repeated this year on a number of fig trees that were badly infested with nematodes. Judging from the growth of the trees, it is doubtful if these pests can be controlled sufficiently, for the trees to ever produce profitable crops of fruit.

Citrus: Two trees of Nippon Orangequat planted as pot plants in the spring of 1933 produced some fruit. One tree produced 42 and the other 84 fruit. However it appears to be of little value unless it can be used as root stock for more desirable fruits. Several of the Satsuma oranges that survived the cold weather of several years ago produced light yields of fruit.

Pears: The two trees of the Hybrid pear, T.S. No. 7493, produced 251 and 229 pounds, respectively.

Tung Seedlings: Seedlings of Tung oil were distributed to a number of parties, and one acre was planted on this station. Several of the plantings have been reported to be growing fairly satisfactorily. However the trees on this station have not made any great amount of growth.

Other Fruits: Two trees of the Methley plum produced good yields of fruit. None of the other fruit trees produced fruit. However quite a few bloomed and set small fruit which was killed by the spray from an oil well that got out of control for several days. This spray also killed the small fruit on several pecan trees on the station grounds.

Ornamentals: Approximately 25 different ornamentals were obtained from the Division of Plant Exploration and Introduction, Bureau of Plant Industry. All of these were small plants. Approximately one-third of these survived the first summer, but none of the living plants have made sufficient growth to permit any definite conclusions as to their adaptability for this locality.

R. H. Wyche.

SUBSTATION NO. 5, TEMPLE

Substation No. 5 is located 2 miles south of Temple and one-half mile west of the Temple-Taylor highway No. 95. The latitude is 31 degrees and 3 minutes north, the longitude 97 degrees and 21 minutes west, and the elevation 660 feet above sea level. The average annual rainfall over a period of 24 years, 1913 to 1936 inclusive, is 35.48 inches, while for 1936 it was 40.08 inches. During the 24-year period an average of only 6.26 inches of rain fell in the months of June, July, and August. The

rainfall for these months in 1936 was 8.78 inches. The 24-year average rainfall for the six-month period, May to October inclusive, is 18.44 inches, while 29.79 inches fell during these months in 1936.

The Station consists of a total of 647 acres of land, 106 acres of which are leased. For a number of years the State has owned 94 acres of land, and during 1936 the Soil Conservation Service of the U. S. Department of Agriculture purchased an additional 447 acres adjacent to the State properties to be used in cooperation with the Station in soil conservation research. The soil on the Station is typical of the Blackland region and is predominantly of the Houston series. All land is in cultivation except that occupied by farmsteads, roads, ditches, and natural drainage ways. There are approximately 34 acres of pasture along Boggy Creek, which is the major drainage way through the Station.

The purpose of this Station is to aid the development of the agriculture of the Blacklands, particularly through the solution of the major crop and soil problems of the region. The soils of the region that have been well preserved are very fertile and are admirably adapted to cotton culture. Many of the outstanding problems have arisen through the exploitation of these soils in the excessive production of cotton. The objectives of this Station are: the control of the cotton root rot disease; the prevention of soil erosion; the introduction, testing, and improvement of crop varieties; the improvement of soil fertility; and the study of various cropping systems. The cotton root rot problem is being studied by the Station under supervision of the Divisions of Agronomy and Plant Pathology and with the cooperation of the Bureau of Plant Industry of the U. S. Department of Agriculture. The soil erosion problems are being studied by the Soil Conservation Service of the U. S. Department of Agriculture in cooperation with the Station.

The needs for a rational farm program for the area to cope with the diminishing soil fertility, soil erosion, and cotton root rot, all point in a similar direction. Excessive culture of cotton must be avoided in order to preserve the soil and control cotton root rot. Small grains, sorghums, and other grass crops are not only immune from root rot, but if properly handled, may be used to prevent excessive erosion and to improve the soils. When these crops are marketed through desirable classes of livestock, their possibilities as erosion-preventing and soil-building crops are increased as well as their possibilities as income producers. Unfortunately the past research program of the Station did not include livestock experiments, but with the acquisition of additional land during 1936, it is proposed to correct this deficiency. During the coming year livestock projects to supplement cotton farming are to be instituted.

Cotton Root Rot Investigations

(In Cooperation with Bureau of Plant Industry, U. S. Department of Agriculture)

Cotton root rot (*Phymatotrichum omnivorum*) investigations under way at the present time are: (1) effectiveness of various cropping systems,

including clean fallows, in reducing the severity of the disease; (2) determining the effect of these same cropping systems on the increase or decrease in number and viability of sclerotia; (3) testing the resistance of field crop legumes and cotton; and (4) laboratory and greenhouse studies of the disease and causal fungus and host.

Viability of Sclerotia: Sclerotia produced in lantern globes of soil from infected cotton roots and buried in the soil at one-, two-, and three-foot depths had an average viability of 71.9 per cent at the end of 38 months. Those buried at one-foot depth had a viability of 66.7 per cent, those at two-foot depth 97.2 per cent, and those at three feet 67.3 per cent. Globes are excavated in triplicate from each depth at six-month intervals on April 1 and October 1.

Clean Fallow as Affecting Root Rot: Acre E-6 on the Substation has been kept in clean fallow since 1930 and acre G-2 since the end of the growing season in 1933. Cotton planted in 1935 on acre E-6, after five and one-half years of clean fallow, had an end season root rot kill of 6.7 per cent. Part of the area planted to cotton continuously for three years after three-year fallow had 98.2 per cent of the cotton killed by root rot in the same year. Both areas planted again to cotton in 1936 had a 92.9 per cent kill on the part having only 6.7 per cent in 1935, and a 98 per cent kill on the part having 98.2 per cent dead in 1935. About two-thirds of this area still remains in clean fallow.

Ten rows were planted to cotton on G-2 after two years of clean fallow. There was an end-season kill of 67.6 per cent on this area. A sorghum barrier separates the areas in cotton from the fallow in addition to separating the successively planted areas within each acre.

Effect of Continuous Sorghum on Root Rot: Twelve rows on the acre used for this study were planted to cotton as a root rot indicator crop in 1936, after two years of continuous sorghum. There was an end-season kill of 58.7 per cent on this area as against 67.6 per cent on the adjoining acre clean fallowed for two years, and 73 per cent on acre E-1, the nearest check, planted continuously to cotton since 1927. Like the clean fallow areas, particular care is taken to keep this acre free of susceptible weeds.

Rotations as Affecting Viability and Distribution of Sclerotia: Soil sampling for sclerotial analysis has been completed in four different three-year rotations and on a nearby check acre planted continuously to cotton since the beginning of the rotation period in 1928. Samples were taken with a 7-inch post hole auger to a depth of 3 feet at the rate of 320 per acre during the period November, 1935, to April, 1936. The 320 post hole samples represent approximately 1/500 of the soil volume in an acre to the 3-foot depth. In the analysis the first, second, and third foot were kept separate. Rotation No. 3 consisted of cotton, corn, oats; No. 5, cotton, oats, cotton; No. 4, cotton, sorghum, oats; and No. 6, cotton, fallow, cotton. In rotation No. 3 an average of 23,463 sclerotia

was found per acre, 10,803 or 46 per cent of which were viable; in rotation No. 5 an average of 7,837 was found, 5,340 or 68.1 per cent of which were viable; in rotation No. 4 an average of 20,269 was found, 12,400 or 61.2 per cent of which were viable; and in rotation No. 6 an average of 14,481 was found, 10,197 or 70.4 per cent of which were viable. A total of 18,202 sclerotia was found in the check acre, F-6, of which 54.7 per cent were viable.

Effect of Certain Chemicals on the Production of Cotton and Cowpeas in Root Rot Areas: To determine the toxic effect on the root rot fungus and stimulating effect on hosts, boric acid, copper sulfate, iron sulfate, magnesium sulfate, manganese sulfate, and zinc sulfate were used at rates varying from 10 to 200 pounds per acre under Qualla cotton and Brabham and blackeye cowpeas in small field plots. Neither root rot infection nor yields were consistent in different plots of the same treatment. The most consistent yield obtained for any individual treatment was from a 1935 planting not completed for that year's report. In this series of plots there was no interference from root rot and apparently none from insects. Plots were treated with 25, 50, and 200 pounds per acre of copper sulfate. Treatments were replicated four times. An average of 8 checks gave 620 pounds seed cotton or 249 pounds lint cotton, and the averages for the different treatments were: 680 pounds seed cotton or 273 pounds lint cotton for the 200 pounds per acre of copper sulfate; 780 pounds seed cotton or 313 pounds lint cotton for the 50 pound per acre of copper sulfate; and 960 pounds seed cotton or 385 pounds lint cotton for the 25 pounds per acre of copper sulfate. With increase in the rate of application of copper sulfate, the yield decreased. The highest single cotton yield for 1936 was 1400 pounds of seed cotton giving 600 pounds of lint from a plot treated with 10 pounds of zinc sulfate per acre. The highest single yield of cowpeas (all plant above ground) was 18.550 pounds green weight from a plot of Brabham variety treated with 10 pounds of copper sulfate per acre. Other plots of the same treatment varied below these figures and in many cases below adjoining checks.

Boric acid, used as a source of boron, was very toxic to both cowpeas and cotton at the rate of 200 pounds per acre, especially where it had been applied for three successive years.

Brabham cowpeas had much higher yields than the blackeye variety due to a higher resistance to root rot and to the fact that they show no chlorosis typical of blackeye peas grown in the Blacklands. There is little doubt but that the chlorotic condition has a stunting effect.

Analysis of Cottonseed from Green Cotton Plants and from Cotton Plants Killed by Root Rot: Oil and protein analyses were made of cottonseed from plants killed early, from plants killed in mid or late season, and from plants still green at the end of the 1935 season. The average analyses of seed were: from early killed plants, 7.62 per cent oil and 22.18 per cent protein; from late season killed plants, 16.01 per

cent oil and 23.36 per cent protein; and from plants green at the end of the season or time of picking, 17.84 per cent oil and 23.14 per cent protein. Samples for analysis were picked in October, 1935, and the analysis was made during 1936. Bolls from plants green at picking time were twice as heavy as those from plants killed early in the season.

C. H. Rogers.

Soil-Erosion and Moisture-Conservation Investigations

(In Cooperation with the Soil Conservation Service, U. S. Department of Agriculture)

Control plots are located on 4 per cent and 2 per cent slopes. Strip-cropping, row-direction, and contour farming are under experiment on relatively large areas. The work on pasture and meadow grasses, in connection with erosion control, is being expanded.

There are 27 control plots which range from 1/200 acre to 2.2 acres in size. These plots furnish data in connection with slope length, row direction, crop rotation, green manure, and vegetative control of soil erosion.

There are 20 experimental terraces which have a combined watershed area of 46.29 acres. The total area protected by terraces is 132.3 acres.

Various kinds of check dams for ditch protection have been built in order to determine the most efficient and economical type of structure.

Tile drainage for the Blackland is also under experiment.

The 1936 data submitted herewith cover the period from January 1 to December 31. During this period, 10 rain gauges recorded total rainfall ranging from 39.01 inches to 41.44 inches.

During 1936, the U. S. Department of Agriculture purchased 447 acres of land for soil conservation research, a part of which will be developed in 1937. In the meantime, leases have been canceled on several areas. The total area available for soil conservation research at the Temple Station, as of January 1, 1937, is approximately 556 acres.

Control Plots: At the control plots immediately north of the office, where the slope is 4 per cent, the 1936 rainfall was 39.85 inches. The soil is Houston black clay. Two plots having cotton rows up and down the slope lost 53 tons and 54 tons of soil per acre. Two plots having corn rows up and down the slope lost 38 and 52 tons of soil per acre. A plot of Bermuda grass lost .013 ton of soil per acre. A plot of oats lost 3.6 tons of soil per acre, but nearly all of this loss was sustained after the stubble had been turned under. It is noteworthy that soil losses were heavy on 7 of the 11 plots and that approximately one-half of the total year's soil loss on these plots occurred on July 4, when 5 inches of rain fell in 3½ hours.

At the control plots one-fourth mile west of the office, where the slope is 2 per cent, the 1936 rainfall was 39.01 inches. The soil is Houston black clay. Where the crop rows are down slope, the soil losses per acre were as follows: corn, 13 tons and 18 tons; cotton, 16 tons; oats, .9 ton. A Bermuda grass plot on this slope sustained no soil or water loss. It is evident that slopes even as gentle as 2 per cent should be protected against soil erosion.

Strip Cropping, Row Direction, Contouring: Plots 23, 24, and 25 are located nearly 3 miles southeast of the station. The soil is Houston clay and the land slope varies from 4 per cent to 6 per cent. The variation in slope is uniform on all 3 plots. In the data cited the 1933 records started with a rain of 4.99 inches on July 30, and for 1936 no records of run-off water were obtained because of leaky silt boxes.

Plot 23 contains 1.38 acres. The land is strip-cropped so that each year there are two strips of oats and two strips of cotton planted on contour, the two crops being equal in area. Hairy winter vetch is planted in the fall on the two strips intended for cotton. The two crops of cotton and oats are rotated; therefore cotton, a crop which permits relatively heavy soil erosion, is grown every other year on the strip next to the silt box where the eroded soil is caught and measured. The following table, showing soil and water losses from 1933 to 1936, indicates the value of having a thick-rooted crop, like oats, occupy the lower-most strip on the slope.

Plot No.	Crop on strip at bottom of plot	Year	Rainfall	Erosion per acre	Run-off per cent
			inches	tons	
23	Oats.....	1933	11.72	.41	1.21
23	Cotton.....	1934	27.95	9.60	8.24
23	Oats.....	1935	45.01	2.66	11.51
23	Cotton.....	1936	41.44	19.42	No record

Undoubtedly, it would be good practice to maintain a permanent meadow strip of little bluestem at the foot of sloping fields.

It is a common practice in the Blackland region to have rows of cultivated crops run up and down the slope. This plan permits severe soil losses through sheet erosion, as indicated by the data from plot 24, given in the following table:

Plot No.	Cropping treatment	Size	Year	Erosion Per acre	Run-off Per cent
		acre		tons	
24	Rows down slope.....	.14	1933	4.18	9.31
	Continuous cotton.....		1934	29.84	15.06
			1935	104.58	25.05
			1936	99.17	No record
25	Rows on contour.....	1.39	1933	7.75	12.98
	Continuous cotton.....		1934	31.26	15.5
			1935	87.36	26.81
			1936	98.06	No record

Crop rows should be on contour, but severe soil erosion will be incurred unless the rows of contoured cultivated crops are supplemented by strips of thick-rooted crops such as oats or sorghum, or by terraces. Plot 25 furnishes data as to contour farming alone. Rainfall is the same for these two plots as for plot 23.

Grasses: Since it is known that grass is efficient in the control of soil erosion, work on securing desirable grasses for the Blackland continues to be of utmost importance. At the present time there are 49 grasses under observation. Of this number, the following grasses appear to have unusual promise: buffalo, curly mesquite, woolly-finger St. Lucie, Dallis, switchgrass, blue grama, and side-oats grama. *Andropogon caricosus*, *Eragrostis curvula*, and *Paspalum hartwegianum* are well adapted to the Blackland.

E. B. Deeter, S. C. S.

Terrace Studies: Experiments relating to vertical intervals between terraces are being conducted on 5.4 per cent and 3.1 per cent slopes. The data secured, thus far, indicate that a vertical interval of approximately 3 feet is best for the Blackland.

Level, uniform, and variable-grade terraces are under experiment. During wet seasons farm operations have been delayed and there has been some crop loss in the channels of level terraces. The soil loss from variable-grade terraces has been slightly less than that from terraces of uniform grade. However, the difference is slight, and terraces having a uniform grade of 2 or 3 inches per 100 feet have performed satisfactorily.

Terraces should be not less than 18 inches in height. A minimum base width of 25 to 30 feet permits relative ease in farm operations and terrace maintenance.

Terraces have been cultivated with crop rows parallel to terraces, and also with crop rows parallel to land lines, crossing terraces at random. Both data and observation indicate that crops should be cultivated parallel to terraces. The effective height of a terrace is quickly destroyed where farm implements cross it at random.

Check Dams: The various types of check dams used at the station are listed in the order of decreasing performance and economy of construction and maintenance: rock masonry, formless concrete, form concrete, wood, metal, woven wire.

Rock masonry check dams are the most economical to construct and have functioned better than any other type used to date in the ditches at the terrace outlets on this station.

Tile Drainage: Tile drains were installed below the surface of terrace channels. The terraces were level, with closed ends. The results have not been satisfactory, and after four years' trial the experiment was abandoned. Water stood for days in the terrace channels, causing

destruction of the crop. There were also delay and inconvenience in plowing and cultivating. It is evident that Houston clay is sufficiently impervious to prevent water passing downward from the terrace channel to the tile line beneath.

Where terraces cross gullies, it is usually necessary to use a fresno or slip scraper to bring the terrace up to proper grade. It is common for rainwater to collect and stand for weeks in the basins thus formed back of the terraces. This trouble may be eliminated by installing a tile drain under the gully, with a vertical tile riser and screened inlet to serve each depression.

P. L. Hopkins, S. C. S.

Field Crop Studies

In the general crop and soil experiments conducted on the station, an attempt is made to furnish not only the basic information upon which the cotton root rot and soil erosion investigations are predicated but also to supplement these specialized studies in such a way as to complete a well-balanced research program on crops and soils for the Blackland region. The work specifically treated in this section is only that part of the field work for which a progress report is justified at this time.

Cotton Variety Tests: The yields in the 1936 cotton variety test were unusually high as shown by the average of 284 pounds of lint cotton per acre for the twelve standard varieties. Roger's Acala, Cliett, Ferguson 406, Harper, Kasch, Lankart, Gorham's Lone Star, O'Conner-Hasselfield's Lone Star, Mebane Estate strain of Mebane, New Boykin, Qualla, and Wacona are the standard cotton varieties that have been grown each year during the nine-year test period, 1928 to 1936 inclusive. The average yield of these varieties is used as a basis by which to rate such other cottons as have not been grown each year. All yield comparisons are on the basis of pounds of lint cotton per acre.

The average of the standard varieties for the entire nine-year test period is 265 pounds of lint per acre. The average yields for the standard cottons by individual years are: 378 lbs., 1933; 324 lbs., 1931; 284 lbs., 1936; 262 lbs., 1935; 262 lbs., 1932; 257 lbs., 1928; 236 lbs., 1934; 229 lbs., 1930; and 155 lbs. of lint per acre in 1929. The yield of 1936 was exceeded by only two other years, those of 1933 and 1931. Compared to the average yield for the standard varieties for the entire period, the 1936 yield was 19 pounds above the average.

Of the eighteen varieties of cotton tested this season, 14 made yields of over one-half bale to the acre. Three varieties yielded more than $\frac{3}{4}$ bale, and the highest yielding variety produced more than $\frac{3}{4}$ bale. Roger's Acala was the outstanding variety of the year and yielded 381 pounds of lint per acre. This variety was followed by O'Conner-Hasselfield's Lone Star and the A. D. Mebane strain with yields of 355 and 339 pounds of lint per acre respectively. Gorham's Lone Star, Watson, New

Boykin, and Qualla all produced in excess of 300 pounds of lint per acre. Their yields were 318, 318, 308, and 306 pounds, respectively.

Roger's Acala, which was the highest yielder for the year, produced a staple length of 1 3/32 inches. The ginning per cent of this cotton was 34.3 per cent and the bolls averaged 5.9 grams of seed cotton each. The relatively small size of bolls is the greatest handicap to this variety.

On the basis of the yield of standard varieties, the individual cottons grown for five or more years and receiving the highest ratings as to comparable yield for the entire test are: Roger's Acala, 293 lbs.; Ferguson's 406 strain, 280 lbs.; O'Conner-Hasselfield's Lone Star, 279 lbs.; A. D. Mebane strain, 277 lbs.; New Boykin, 277 lbs.; Qualla, 268 lbs.; and Wacona, 265 lbs.

Corn Variety Test: The corn yields in the 1936 corn variety test were very high as is shown by the average of 39.4 bushels of shelled corn per acre for the five standard varieties. Reese's Drouth Resister, Ferguson's Surcropper, Ferguson's Yellow Dent, Nicholsons' Giant Yellow, and Chisholm are standard corn varieties that have been grown each year during the nine-year test period. The average yield of these varieties is used as a basis by which to rate such other corn varieties as have not been grown each year. All comparisons are on the basis of bushels of shelled corn per acre.

The average yield of the standard varieties for the entire nine-year test period, 1928-1936, is 31.3 bushels. The average yields of these standard corns by individual years from the largest to the smallest amount of shelled corn per acre are: 39.4, 1936; 38.8, 1932; 38.2, 1930; 36.9, 1935; 35.4, 1929; 27.8, 1931; 26.7, 1933; 24.3, 1928; and 14.1, 1934. The yield for 1936 was the highest and for 1934 the lowest during the period.

Four individual corn varieties yielded in excess of 40 bushels per acre in 1936. They were Ferguson's Yellow Dent, 42.8; Nelson's Native, 42.4; Leudtke Yellow Sure, 41.7; and Blankenmeyer White Dent, 41.7. The varieties that have been grown for four or more years and received a high average rating are to be recommended for farmer's use. These include Ferguson Surcropper with an average yield of 32.5 bushels per acre; Red June, 32.5; Leudtke's Yellow Sure, 32.3; Reese's Drouth Resister, 32.3; and Ferguson Yellow Dent, 31.8.

Hybrid Strain Test of Corn: In 1936 hybrid strain tests of corn, 48 hybrid strains were tested. Sixteen of these hybrids were inbred strains crossed with Gorham Yellow Dent, and 32 were crossed with Surcropper. The inbred strains were isolated from Mosshart Yellow Dent, with the exception of a few which were isolated from Pigg Yellow Dent, a corn quite similar to Mosshart. The comparative yield of these hybrids was determined by comparison to the average yield of four standard corns, Gorham Yellow Dent, Ferguson Yellow Dent,

Surcropper, and Mexican June. Few of the Gorham Yellow Dent hybrids made outstanding yields. However, over half of the Surcropper hybrids gave an increase of over 30 per cent compared to the standard corn varieties. Three outstanding Surcropper hybrids showed an increase of 50 per cent compared to the checks.

Small Grain Rust Resistance Test: The small grain improvement work conducted at the Temple Station in 1936 was confined to testing the yields of rust resistant wheat and oats. A total of 19 wheat selections and 46 oat selections were grown. In addition, Denton wheat and five named varieties of oats were also tested. The comparative yield rating of the wheats was based on the performance of the bulked seed of wheat selection No. 41 and the oats were rated on the basis of Nortex.

Based on the average yield of the two nearest checks, nine of the 19 wheat selections tested produced from 16 to 41 per cent more than their checks. Wheat 41-17-3 and 41-26-1-1 were very outstanding and yielded at the rate of 32.6 and 32.3 bushels per acre compared to the average of 23.1 bushels for the wheat used as a check.

Out of the 46 oat selections tested, eight produced from 2 to 34 per cent more than the checks. Based on the average production of 64.5 bushels of oats per acre for the Nortex check, selections M19-18, M3-2, M6-13 yielded 86, 79, and 78 bushels per acre, respectively.

Grain Sorghum Variety Test: The 1936 sorghum crop was only moderately productive as both the forage and grain yields for this season were slightly below the average for the past nine years. Leoti, with a yield of 23.2 bushels of threshed grain per acre, exceeded all other varieties. This performance was unusual since Leoti is a sweet sorghum. The yield of 21.4 bushels of grain per acre for Chiltex was the highest for any of the grain sorghums. Darso was the third highest with a yield of 20.4 bushels of grain per acre. The forage yields for these varieties were 3.12, 2.60, and 3.12 tons of dry forage per acre, respectively. The highest forage yields for the year were 5.08 tons of dry forage per acre for African Millet, 3.12 for Leoti, and 3.12 for Darso. The yield of forage for Sumac of 2.76 tons per acre for 1936 was lower than usual and was exceeded by three of the grain sorghums: Darso, 3.12 tons; Schrock, 3.05 tons; and Spur feterita, 2.92 tons.

For the nine-year period 1928 to 1936, the three highest grain yielding varieties were as follows: Darso with 28.0 bushels of grain per acre, Chiltex 25.7, and Schrock 23.2. During the same nine years these varieties produced an average of 3.42, 2.34, and 3.62 tons of dry forage per acre, respectively.

The highest forage yielding sorghums have been tested only three years. However the records for this period are considered quite significant since the yields for 1934 were very low, those for 1935 very high,

and those for 1936 approximately average. The three-year average yields of African Millet, Leoti, and Sumac were 4.85, 4.00, and 3.85 tons of dry forage, and 13.3, 23.8, and 13.3 bushels of grain per acre.

Legume Variety Test: Unfavorable soil conditions prevented the planting of the 1935-1936 winter legume test until March, 1936. At that time 21 legumes were planted. Of these, Hubam was the most outstanding. This clover was planted on March 5, and by June 9 had yielded 3.4 tons of cured forage that was available to be turned under as a green manure. At the time of harvesting the yield samples, none of the Hubam clover had died from cotton root rot.

On April 20 the 1936 spring legume test was planted. This test included 5 varieties of soybeans, 5 of lespedeza, 2 of crotalaria, 2 of velvet beans, and 1 of cowpeas. The most outstanding spring legumes were guar and sesbania, which produced 3.0 and 3.4 tons of dried forage per acre, respectively. Uninoculated sesbania produced nodules in abundance while guar produced practically none.

Cropping Systems

Continuous Cotton Studies: The rotation studies at Temple involved the growing of cotton continuously on check areas on two soil types and in eleven types of rotations. Continuous cotton grown in Houston clay and Houston black clay exhibited an initial cotton yielding capacity of 155 and 226 pounds of lint cotton per acre, respectively, for the pre-rotation period of 1928-1930. During the period the rotations were effective, the continuous cotton checks yielded 165 and 237 pounds of lint cotton per acre, respectively, for the Houston clay and Houston black clay. This performance is evidence that the yield of these areas was not seriously impaired by these relatively short period of continuous cotton, and the actual increase in yield during the second period is credited to more favorable weather conditions.

The root rot losses to cotton stands on the continuous cotton areas averaged 43 and 49 per cent on the Houston clay for the pre-rotation and the effective rotation periods, respectively. For the same periods, the root rot kill on the Houston black clay was 62 and 67 per cent, respectively. From this citation it is seen that root rot losses were higher under the more favorable soil and weather conditions that were conducive to high cotton yields. In general the soil and weather favorable to high cotton yields are also favorable for high root rot kill. Over a period of years the low average yields of continuous cotton were more closely associated with unproductive soil and unfavorable weather conditions than with high root rot losses.

The soil on the Houston black clay area devoted continuously to cotton was very productive and gave high cotton yields even under severe root rot conditions. Undoubtedly root rot took a minor toll in the reduced

cotton yields in every year in which cotton was grown on the Houston black clay area and in which root rot occurred. During four of the nine years cotton was grown on this area, root rot losses exceeded 90 per cent. In 1928 and 1933 this excessive kill had very little apparent effect on yield as the average of these two years exceeded one-half bale per acre. However, in both 1935 and 1936 the high root rot kills were associated with very low yields. The average yield on this area for 1935 and 1936 was only 149 pounds of lint per acre, or 77 pounds less than the average. This is indicative of the root rot hazard attendant on the continuous planting of cotton on the same land.

Cotton Rotations; Effect of Frequency with Which Cotton Appears in Rotations: The rotations on the Temple Station were effective during the period 1931-1936 and furnish information on the effect of frequency with which cotton was used in the rotation, the effect of soil type, and the effect of the preceding crop on the yield of cotton and the per cent of root rot. From the data available on the frequency with which cotton appeared, it is evident that all rotations increased the yield over continuous planting of cotton. The use of cotton two-thirds of the time increased the yield 9 per cent; one-half of the time, 11 per cent; one-third of the time, 26 per cent; and one-fourth of the time 35 per cent. When cotton appeared in the rotation more frequently than once every third year, root rot was not controlled. In fact, if the data are to be interpreted literally, it appears that the occasional rotation of cotton with a non-susceptible crop had a stimulating effect on root rot. The use of cotton once in four years was by far the most effective in controlling root rot. The use of cotton two-thirds of the time increased root rot 22 per cent and one-half of the time, 6 per cent; while the use of cotton one-third of the time reduced root rot 18 per cent, and one-fourth of the time, 64 per cent when compared to the performance of the continuous cotton.

Cotton Rotation; Effect of Previous Crops: The principal crops used in rotation with cotton were corn, sorghum, and oats. These crops were used in most of the rotations, but comparable data on the effect of the previous crop on cotton were available for only the two-year and the modified four-year rotations. Since both of these types of rotation used cotton every other year, root rot was not controlled. From a consideration of the changes occurring in both yield and root rot kill in cotton preceded by corn, sorghum, and oats, respectively, it was found that the changes in root rot kill were not closely associated with the changes in cotton yield. When corn, sorghum, and oats preceded cotton, the yields of cotton were increased on an average of 23, 12, and 2 per cent, respectively, compared to the continuous cotton check, while the root rot kill was increased 28, 8, and 8 per cent. On a comparative basis, the root rot kill in cotton was much more when cotton was preceded by corn, yet the yield of cotton was greatest when preceded by corn. The data available indicate that relatively larger quantities of crop residue were turned under in preparing the corn land for cotton than was the

case for the other two non-susceptible crops. It appears that these additions of organic matter were quite effective in increasing the cotton yields even in spite of the higher root rot kills. The root rot kill in cotton following corn was higher than following the other crops, largely because corn tolerates the growth of numerous susceptible weeds.

A single two-year rotation of cotton and guar employed a legume. In common with other two-year rotations, this practice failed to control root rot. In comparable rotations, the yield increases of cotton following guar were 24 per cent more than for continuous cotton, compared to 27 per cent when cotton followed corn. However, the root rot kill following guar was much less than when cotton followed corn. Following corn, the root rot kill was 21 per cent greater than for continuous cotton, while it was 6 per cent less following guar. The apparent superiority of guar in controlling root rot is probably accounted for by better weed control in the guar. Guar is a highly resistant legume, and as used in this rotation, was planted in rows. Cultivation of guar extended much later in the summer than the cultivation of corn, and in addition to that, guar smothers out late summer weeds. Since the guar was harvested and only a limited amount of crop residue was turned under, it did not increase the yield of cotton as much as did the corn.

Cotton Rotation with Clean Fallow: Another variation in these rotations was the use of clean fallow one-third of the time. The rotation consisted of cotton, cotton, fallow. Although the fallowing practice stimulated cotton growth, it also stimulated root rot kill. The stimulation of cotton was greatest the second year following the fallow. The yield of the cotton immediately following fallow was 8 per cent greater than for continuous cotton, while root rot kill was 22 per cent greater. The yield of the second cotton crop following the fallow was increased 13 per cent and the root rot was decreased 15 per cent.

Corn Rotation: The rotation studies with corn during the period 1931 to 1936 show that corn yields were increased 28, 27, and 28 per cent in two-, three-, and four-year rotations, respectively, when compared to continuous cropping of corn. All rotations gave approximately the same increase and indicate that a two-year rotation is sufficient for corn. In all these rotations cotton preceded corn.

Oats Rotation: The growing of oats in rotation with other crops during the period 1931-1936 did not materially increase the yield of oats compared to continuous cropping. In the several rotations studied the yield of oats was higher than for continuous oats in three cases, the same in one case, and less in three other cases. The average yield of oats in all rotations was only 5 per cent greater than the yield of continuous oats. The oat yields in the rotation in which cotton was the preceding crop were 12.3 per cent higher than those of continuous oats, while the yields following corn and sorghum were 10.5 and 15.0 per cent less, respectively, than the check.

Sorghum in Rotation: During the period 1931-1936 sorghum planted in rows was grown continuously on two soil types and in four types of rotations. Darso was the sorghum variety used. From the data available it is evident that the sorghum grown in rotation yielded considerably more grain and forage than sorghum grown continuously on the same land. On the average, sorghum in rotation yielded 45.2 per cent more grain and 58 per cent more forage than did the sorghum on the continuous check.

Fertility Studies

Residual Effect of Fertilizer on Corn: (In Cooperation with Bureau of Plant Industry, U. S. Department of Agriculture.) The area previously used for a cotton fertilizer test was planted to corn in 1936. To test the effect of fertilizer applications in previous years, no applications were made in 1936. The results secured showed fertilizer containing both nitrogen and phosphoric acid in most instances increased the yields of corn. The same fertilizer also showed the greatest effect on cotton the previous year.

H. E. Rea, S. D. Snyder.

Crop Pests

Angular Leaf Spot on Different Varieties of Cotton: Angular leaf spot, *Bacterium malvacearum*, of cotton was unusually severe during the 1936 growing season due to the high rainfall during May and July. Since there appeared to be some difference in degree of infection from row to row in the variety test, a survey was made on one of the acres on which 18 different varieties appeared six times. Infection counts were obtained from 10 plants in each replication. Leaf infection varied from a low of 20.3 per cent for Wacona to a high of 55.7 per cent for New Boykin. Bract infection varied from 18.5 per cent for Lankart to 36.7 per cent for New Mexico Acala. Actual boll infection varied from 1.7 per cent for Cliett to 6.6 per cent for Roger's Acala. Average infection for the entire acre was: leaves 35.2 per cent, bracts 29.6 per cent, and bolls 3.6 per cent. The severe leaf infection occurring early, together with the boll infection, resulted in a probable loss near the boll infection percentage. If infected bolls open, the lint is usually stained and the quality lowered.

Insect Pests: Lice on cucurbits and cowpeas have been rather severe in a number of locations. An important insect described as the vegetable weevil *Listroderes obliquus* Gyll, and new to this area, was found in one location doing considerable damage to young potato and bean plants. Borers tunneling in small twigs of conifers, causing them to lop over and die, have caused considerable damage.

Bagworms, usually confined to attacking conifers, have been found defoliating pecan trees adjacent to coniferous plantings during the past summer.

As usual, many complaints have been received regarding infestations of the usual household, garden, and orchard pests, such as ants, snails, termites, cockroaches, silverfish, borers, etc. Snails were very numerous due to the rather wet season.

Flea hoppers and boll worms on cotton were rather prevalent in central Texas during the 1936 season. Considerable leaf worm damage was noticed in other parts of the Blacklands. Although the season was unusually wet, no great amount of damage was attributed to the boll weevil.

Miscellaneous Diseases: Angular leaf spot on cotton has been unusually severe this year due to the rather wet season. Ordinarily there is a fair amount of leaf damage. However this year there was considerable boll damage lowering both yield and quality. Many bolls examined failed to mature and open where there was severe infection. The lint in bolls less severely infected was stained to a varying extent.

Mildew on a number of ornamentals and vegetable and field crops was also unusually severe due to the wet weather. Such plants as crape myrtle, rose, zinnia, cowpea, and bean were infected. Where root knot organisms occurred, they were rather severe, attacking cowpeas, beans, cabbage, tomatoes, lettuce, and okra.

Some of the other more important diseases observed were brown leaf spot of pecan, crown rust of oats, stem rust of oats and wheat, leaf blight of arborvitae, bacterial leaf spot of peach, and cotton root rot of a number of plants. A field of cultivated hemp in Ellis county was found severely infested with cotton root rot.

A list of plant diseases for the year has been compiled for the Plant Disease Survey.

C. H. Rogers.

SUBSTATION NO. 6, DENTON

Substation No. 6, five and one-half miles northwest of Denton, is 600 feet above sea level. The average annual rainfall for a period of 23 years is 32.86 inches, 20 per cent falling in December, January, February; 32 per cent in March, April, May; 24 per cent in June, July, August; and 24 per cent in September, October and November. The average dates of the last killing frost in the spring and the first in the fall are March 24 and November 12, respectively. This station is in the important wheat and oat producing area of North Texas. The predominating soils are clays of the San Saba and Denton series, which are typically developed on the Fort Worth Prairie, the northern part of the Grand Prairie Region. The Station comprises an area of 209.92 acres.

The primary objects of this Station are the improvement of small grains adapted to the wheat- and oat-growing region of North Texas,

and the development and improvement of other crops for this region. Field crops, such as cotton, corn, and grain sorghums are included in the experiments at this Station. Plant introduction tests, with particular emphasis on legumes for use as pasture and soil-improvement crops, are an important part of the program of this Station.

Small-Grain Investigations

(In cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture)

The small-grain work of the station is carried on in two locations. Extensive experimental work with wheat, oats, and barley is conducted at the Station to improve these crops for North Texas conditions. In addition, improvement work with hard winter wheat is carried on in the Texas Panhandle through cooperation with the Amarillo Chamber of Commerce, county agents, and farmers in that section of the State.

Wheat Investigations (1936): Wheat experiments at Denton consisted of a variety test, fertilizer test, and nursery plantings in which a large number of varieties and new strains were grown. In these tests varieties and strains were tested for resistance to diseases, such as smut and rust; for desirable agronomic factors, such as resistance to lodging, shattering, winter-killing, drought, quality of grain for milling purposes; and for yielding ability.

The field plat variety test consisted of 19 varieties planted in quadruplicate 1/55-acre field plats. Although spring drought caused some damage to the test, in general the season was very favorable for wheat production. The hard winter wheats outyielded the soft winter wheats by a wide margin this season, due to dry weather and lack of the usual rust damage. Leading varieties in yield were Tenmarq, Blackhull, Quivira, and Kanred with yields of 48.0, 47.2, 46.4, and 46.2 bushels per acre, respectively. The most productive soft winter wheat was Clarkan, yielding 45.6 bushels. Denton wheat produced 40.6 bushels per acre while all other soft winter wheats produced less than 40 bushels per acre.

In the period of years, 1927 to 1936, Denton, Mediterranean 3015-81, Blackhull, Kanred, and Fulcaster have been grown continuously, yielding 25.9, 24.8, 24.7, 25.8 and 24.0 bushels per acre, respectively. All other varieties have been grown for shorter periods. Tenmarq and Quivira, varieties developed at the Kansas Experiment Station, have shown up well, outyielding all other varieties for the period in which they have been grown. Tenmarq wheat is now being distributed to farmers in North and West Texas. The only new soft wheat variety of promise at present is Clarkan. This variety has averaged 25.4 bushels per acre for the three-year period in which it has been grown. Denton wheat has averaged 22.0 bushels during the same period.

Nursery Tests: Seventy-seven varieties and strains of hard and soft winter wheat were grown in quadruplicate 3 rod-row plats in the advanced Nursery. Included in this group was the U. S. Department of Agriculture uniform yield nursery of 30 varieties, which is grown at most experiment stations in the Middle Western hard wheat belt. Many hybrid strains developed at Denton, as well as some from other sources, were included.

Leading varieties of hard wheat in the advanced nursery were Kanred x Marquis, T. S. 20391, Quivira, Prelude x Kanred, C. I. 11591, P.1066-1 x Prelude C. I. 11590, and Kanred x (Kanred x Marquis, C. I. 11592) with yields of 42.8, 42.5, 41.5, 40.6 and 40.3, respectively. Leading soft wheat strains were Fulcaster x Imperial Amber, T. S. 20381, Denton x Kanred 4-31-28, Denton x Kanred 4-31-1 and Kanred x Kawvale, T. S. 20413, with yields of 39.0, 37.9, 36.5, and 34.9 bushels, respectively.

A single 3-rod-row plat planting was made of 260 hard wheat selections which are being tested for adaptability to West Texas conditions. The planting at Denton was made to insure seed supplies and to study the reaction to disease, lodging, and shattering. Although the season was favorable for hard winter wheats no strains of great promise were noted. Information on bunt resistance showed many to be resistant to this disease.

A preliminary nursery consisting of 120 strains, mostly of hybrid origin, was grown. Plats consisted of single 3-row, 8-foot plats. In comparison with the Denton checks a number of Denton x Kanred strains appeared promising. Several new leaf rust-resistant strains obtained from Mr. C. O. Johnston, Pathologist, Manhattan, Kansas, also showed promise. Stem rust resistant strains from the Mediterranean and 3015-63 x Hope cross were disappointing in yield this season. Several new bunt resistant strains from the crosses Kanred x Oro and Martin x Tenmarq showed unusual promise in yield, grain type, and agronomic character. These will be planted in replicated nursery plats at both Denton and Amarillo in 1937.

Approximately 1000 head selections of hybrid origin were grown in an attempt to isolate new desirable strains. A large number of bulk hybrids were grown and several new crosses were made during the season.

Cooperative Wheat Variety Tests: From ten to fourteen varieties of winter wheat were sown in cooperative tests in the Texas Panhandle this season. Extremely dry weather throughout the growing season, combined with wind and dust storms, caused failure or very low yields. The cooperative tests at Plainview and Amarillo were irrigated once during the fall to carry them over the winter.

All yields were low this season. Blackhull, Tenmarq, and Cheyenne were the leading varieties. At Amarillo the Turkey types yielded

highest. For the 5-year period, 1931 to 1936, Tenmarq, Blackhull, Kanred, and Cheyenne have produced an average of 13.8, 13.7, 13.4, and 13.2 bushels compared to 12.2 bushels for Certified Turkey wheat. All other varieties tested have yielded less than the above varieties.

A winter wheat nursery consisting of 226 varieties and strains in replicated rod row plats and approximately 300 new hybrid strains in small single rows was planted at Amarillo through the cooperation of the county agent and the Amarillo Chamber of Commerce. Although the test was irrigated once during the winter, drought and soil blowing so damaged the test that no results were obtained.

A cooperative variety test was grown at Greenville, Texas, through the cooperation of the U. S. Cotton Breeding Station. Nine varieties of soft and one of hard winter wheat were grown to study quality of grain for use in pastry flour. Yields and agronomic data were also obtained. The highest yield was produced by Tenmarq, a hard wheat, averaging 24.8 bushels. The second highest yield, 23.2 bushels, was produced by Mediterranean, T. S. 3015-81. Due to a very severe spring drought, conditions were very abnormal which accounts for the high yield of the hard winter wheat. Milling and baking tests on the soft wheat flour will be reported later.

Diseases of Wheat: The two principal diseases of wheat in North Texas are leaf rust and stem rust. Leaf rust is present nearly every year from March until the crop is mature. The damage from this disease probably exceeds the average damage from stem rust. Breeding for resistance is the only practical means of control. Definite progress has been made in the past through selection of rust resistant strains from local wheat. Further progress is now being made by hybridization work. Many new resistant strains are now being grown in the nursery for testing their adaptability. Fall and spring sown cooperative U. S. Department of Agriculture rust nurseries are grown to study occurrence of physiological races of rust.

Stem rust of wheat is present nearly every season in North Texas, doing damage in proportion to the earliness of infection and the favorableness of environmental factors. The spread of the disease in this area is of national importance as it is the first wheat-growing area to mature. The disease overwinters in South and Central Texas on small grains and grasses and spreads northward as the season progresses. The degree to which the disease develops in North Texas determines to a large extent the amount of inoculum which will spread to middle western and northern wheat-growing areas. Breeding for resistance to stem rust is the major project at the Substation. From a cross of Mediterranean 3015-63 x Hope, made in 1928 by Dr. Mangelsdorf, several very promising winter wheat strains resistant to both stem and leaf rust have been developed. These winter strains are being crossed on adapted varieties of soft wheat to further improve agronomic characters.

Numerous hybrid populations and hundreds of selections are being grown in this study. Uniform U. S. Department of Agriculture nurseries are grown to study the occurrence of physiological races and spread of the disease.

Bunt, or stinking smut, is an important disease in West Texas. From crosses of Martin x Tenmarq and Kanred x Oro several new bunt-resistant hard winter wheat strains have been developed. These strains yielded well this season in comparison with parent types.

Loose smut of wheat has become an important factor in yield in recent years. Since infection takes place at blooming time and infection is carried within the seed, the only available method of control is by treating with hot water. This treatment is difficult to make and few farmers will attempt it. Because of lack of facilities, methods of inoculations, and time, very little has been done to solve the problem.

Oat Investigations: Eleven varieties of oats were tested in replicated field plats from both fall and spring seedling. Although oats in general were damaged by drought during the preheading stage, both plantings matured good crops. The leading varieties from fall seeding were Texas Red Rustproof, T. S. 1415-12, T. S. 6217-43, and Appler Rustproof, T. S. 1401-24. These same varieties are also the leading varieties for the period of years, 1932-1936. The highest yielding varieties from spring sowing were Texas Red Rustproof, T. S. 1118-69, Appler Rustproof, T. S. 1401-24, and Texas Red Rustproof, T. S. 6217-43. For the 5 years, 1932 to 1936, the leading varieties from spring sowing were Texas Red Rustproof, T. S. 1415-12, Appler Rustproof, T. S. 1401-24, and Texas Red Rustproof, T. S. 1118-69.

Forty-five varieties and strains were fall sown in replicated nursery plats. Differential winter killing occurred in this test. Red Rustproof strains were injured very little. Fulghum strains were injured and winter-tender strains, such as Victoria and Bond, were almost completely killed. Hybrid strains were injured in varying amounts although few were as winter hardy as the Red Rustproof strains. Yields were in part dependent upon winter injury, the Red Rustproof types yielding highest. Two hybrid strains from the cross of Nortex x Black Mesdag outyielded all others.

Eighty varieties and strains were spring sown in replicated nursery plats. Included in this planting were some forty rust resistant hybrid strains developed at this station from crosses of Nortex x Victoria, Fulghum x Victoria, Kanota x Victoria, and Appler x Bond. The above bulk hybrids were obtained from the U. S. Department of Agriculture. Very little rust developed this season due to the dry weather. Several of these hybrid strains produced yields equal to Nortex this season. It is believed that in a normal season, when rust is a factor in yield, they will be even more promising. Over a period of years the Red Rustproof strains have outyielded Frazier and other Fulghum types from

spring as well as fall seeding. In the replicated nursery Nortex, Texas Red Rustproof T. S. 1415-12, T. S. 985-7, and T. S. 985-1 are the leading varieties.

A preliminary nursery of 160 strains was planted in single 3-row, 7.5-foot plats. Included in this nursery were 55 promising rust-resistant strains from the 1935 head-row nursery. The remainder were newly introduced varieties, hybrid strains from other experiment stations, and a regional test of new smut resistant strains developed at middle western stations. None of the introduced strains was at all promising. Some of the rust-resistant strains developed at this station withstood the drought well and produced yields comparing favorably with Nortex. No data on rust resistance were obtained.

A head-row nursery of some 2700 selections was planted. All seed was smutted before planting, and rust was introduced into the nursery so that rust readings could be made. Only about 200 strains were saved for further testing as all other strains proved susceptible to either rust or smut.

Crown rust, stem rust, and the smuts are important diseases of oats in Texas. As indicated in the above discussions, rapid progress is being made toward producing a red oat for Texas which will be resistant to these diseases. Although progress in stem rust resistance work is not as far advanced as work toward resistance to the other diseases, hybrid material is now being grown which incorporates resistance to all diseases.

Barley Investigations: Eleven varieties of winter barley were fall sown in replicated field plats. Smith S-31-62, a selection from a local variety, made the highest yield. This strain has been outstanding in the nursery for three years. Two new hybrid strains also yielded well this season in comparison with standard varieties.

Fall and spring sown barley nurseries were planted. Ninety-four varieties and strains were fall sown in replicated nursery plats. The majority of these were hybrid strains and some very promising strains appeared. The leading variety was Smith s-31-62, also the leading variety in the field plat test. This variety produced 51.6 bushels per acre compared with 29.6 bushels for Tennessee Winter and 33.1 bushels by Finley, the check variety. Hybrid strain 1-33-249 was second in yield averaging 45.8 bushels. Smith S-31-62 has averaged 43.4 bushels for a 3-year period compared with 34.3 bushels for the check variety Finley, and 30.1 bushels for Tennessee Winter, C. I. 3545.

A spring sown barley nursery of 21 varieties was sown. Included in this test were well-known standard barley varieties together with a number of new selections and hybrid strains. High yields were produced by hybrid strains 1-33-322 and 1-33-425 with yields of 44.7 and 42.1 bushels. Smith S-31-62 produced 41.0 bushels from spring plant-

ing while Vaughn and Stavropol produced only 31.6 and 30.5 bushels respectively.

Flax Investigations: Six varieties of flax were planted in replicated nursery plats on three separate dates. March 10 planting gave much better yields than later plantings. Planting as late as April 8 caused almost complete failure as it has in past years. Leading varieties are North Dakota 113, Rosquin, and Linota, with yields of 13.9, 13.8, and 13.3 bushels per acre, respectively.

Perilla. Through the cooperation of the Division of Drug and Related Plants, U. S. Department of Agriculture, a small planting of perilla was made. Although the plants grew well and survived the drought of midsummer, no blooming or seed setting occurred until late fall. A small amount of seed was set but in general the crop did not appear promising for this section.

J. M. Atkins, Bur. Pl. Ind., and P. B. Dunkle.

Corn Variety Experiments

Eighteen varieties of corn were planted 4 times each on randomized plats on March 6, 1936. Seven new varieties produced by this Substation, or the Texas station, were included in the test this year for direct comparison with the more commonly grown standard varieties. Because of deficient moisture and high temperatures the latter part of June and the early part of July, all varieties ripened prematurely and made lower yields than normal. The late-maturing dent varieties were more severely damaged than the early drought-resistant sorts. Ferguson Surcropper, Reese's Drouth Resister, and a new Synthetic Surcropper, Multisure, made the highest yields of 29.3, 26.9 and 28.1 bushels per acre, respectively. Red June, Synthetic Surcropper No. 1 and No. 2, and Yellow Surcropper yielded approximately the same; while Ferguson Yellow Dent, Dwarf Mexican June, Doyle's Bloody Butcher, Golden June, Denco Yellow Dent and Synthetic, Yellow Dent No. 1 and No. 35 also yielded about the same, the difference between these two being approximately 1 bushel, which is not significant. Teague's Yellow Dent, Mammoth Yellow, Leudtke's Yellow Sure, and Blankenmyer's White made the lowest yields of 13.7, 15.3, 15.7, and 17.9 bushels per acre, respectively. These varieties made the highest yields in the seasonable year of 1935, which clearly shows the need of a long-time average in selecting a variety that will be a consistent and satisfactory producer in this territory. On the basis of average yields over a period of years the more drought-resistant varieties, such as Surcropper, Reese's Drouth Resister, Ferguson Yellow Dent, and Denco Yellow Dent are to be recommended until such time as other common varieties, or new synthetic varieties, have clearly demonstrated their superiority over a period of five years or more.

Inheritance and Improvement in Corn

This project was started in the spring of 1927 for the purpose of studying inherited characters in Surcrotter and Yellow Dent corn and to determine the possibility of using the pure inbred strains for developing a superior variety of each. In addition to a large number of inbred strains of each variety, a large number of crosses between the inbred strains within each variety is grown each year to determine the potential value of the inbred strains involved. When the value of the inbred strains is determined, the most promising are used in multiple crosses which are calculated to combine and maintain factors for resistance to smut, drought resistance, uniformity of type, and high yield. A strain of yellow dent corn developed in this manner has been grown for several years in comparison with ordinary commercial varieties and found to be highly resistant to smut and slightly superior in yield to the average run of yellow dent varieties. Seed of this variety are now ready for distribution to farmers.

Corn Versus Grain Sorghums

This is the 9th year of an experiment on the comparative adaptability and productiveness of corn and grain sorghums in this region. Four varieties of grain sorghum, Darso, Hegari, Chiltex, and Ajax are grown in direct comparison with Surcrotter corn. The grain sorghum varieties made good growth until about the middle of June when dry weather checked growth and prevented normal heading. Darso and Chiltex came into full head about the middle of August, or approximately one month later than normal. Ajax headed very irregularly and Hegari produced no heads. After the rains the latter half of September, all varieties made new growth but produced no additional heads. While Hegari made no heads, it responded more than other varieties to the September rains and produced an exceptionally heavy yield of forage.

The average yield of grain during the 9-year period is 28.8 bushels for Darso, 22.4 for Hegari, 28.8 for Chiltex, and 20.4 for Ajax. The average yield for Surcrotter corn during this same period is 24.1 bushels per acre. The average yields in tons of forage per acre are 3.03 for Darso, 3.16 for Hegari, 2.37 for Chiltex, and 2.27 for Ajax.

From this test it is evident that the best varieties of grain sorghum are at least equal to corn in this region. The value of the forage obtained from the sorghums is perhaps sufficient to offset the greater difficulty of handling the crop and the usual deleterious effect upon the succeeding crops.

The Effect of Grain Sorghum and Corn upon the Succeeding Crops

Since 1929 a study has been made of the influence of sorghum varieties and corn on the yield of grain and straw of oats which followed these

crops in a four-year rotation. Since 1933 this project has been enlarged to include wheat, corn, barley, cotton, and three planting dates of cowpeas. It should now be possible to determine how long the detrimental effect of a sorghum crop persists, as well as what crops are best suited to follow grain sorghums.

The yield of oats shows that the previous crop of corn was considerably less damaging than the previous crop of grain sorghum. The yield of oats following corn was 57.2 bushels, while the yield of oats following sorghum was 53.1 bushels per acre. The yield of oats straw is reduced in about the same proportion as the yield of grain. There appears to be no significant difference between the grain sorghum varieties in their effect upon the yield of the following crop of oats.

The yield of fall-planted barley following corn is considerably higher than that following the grain sorghums, and indicates that fall planted crops are more subject to damage by the previous crop of sorghum than spring-planted crops.

Fall-planted wheat, like the fall-planted barley, yielded much lower when following grain sorghum than when following corn.

There is very little difference in the yields of corn following corn or grain sorghums, indicating that the deleterious effect of grain sorghums on the following crops is largely overcome by soil and moisture conditions favorable to rapid decay of the old sorghum stubs and roots incorporated in the soil.

The average yield of cotton following corn or grain sorghums gives further support to the opinion that the effect of grain sorghums on the following crop is only temporary and is largely governed by factors which promote decay of old sorghum stubble and roots during April and May. Since the yield of cotton is affected very little by the previous crop of grain sorghum it is perhaps the best crop for the farmer to plant following sorghums.

In order to test further the theory that the effect of sorghum upon the following crop is only temporary, cowpeas were planted at three different dates in the spring. The average yields of forage for each date show that the previous crop of grain sorghum did not reduce yields.

Cotton Experiments

A summary of 6 replications of randomized plats of 18 varieties and strains of cotton planted this season shows that Sunshine Sels. 87-5, 117-1, 54-2, 74-2, 74-3, and 103-1 made the highest yields of 227, 223, 216, 215, 214 and 205 pounds of lint per acre, respectively. Watson, New Boykin, Mebane (A.D.), and Harper were next in order with yields of 204, 200, 199 and 197 pounds of lint per acre, respectively. Webbs

Purple, Half and Half, and D.P.L.-11A made the lowest yields of 70, 110 and 110 pounds per acre, respectively. The low yield of all varieties was very largely due to the extremely high temperatures and hot winds in August. The comparable average yields of varieties grown for 6 years or longer are as follows: Half and Half, 314; Watson, 296; New Boykin, 293; Cliett, 286; Ferguson 406, 285; Sunshine, 273; Harper, 265; Qualla, 262; Acala 261; Mebane (A.D.), 260; Aldridge (Kasch), 260; Lone Star (Gorham), 257; and Lankart, 242.

Cotton Breeding: Twenty-eight inbred lines of Sunshine cotton, T. S. No. 10104, were planted in 4 replications of randomized plats. The purpose of this test is to determine the effect of inbreeding on the general uniformity of plant growth, boll type, maturity, staple length and other characters in comparison with those of the common Sunshine parent. Thus far in this work several very excellent strains have been obtained. Two of the best strains are being increased for distribution to farmers.

Fertilizers

The six acres devoted to fertilizer experiments are in two three-year rotations of wheat, cotton, and corn. The wheat follows corn and corn follows cotton. A 4-12-4 commercial fertilizer applied at the rate of 400 pounds per acre is used as the basis of the experiment. The percentage of each element and the rate of application are then varied so that the proper fertilizer formula and the proper rate of application can be determined.

The yields of cotton in this test this year are considerably lower than normal because of damage done by the extremely high temperatures and hot winds in August. Yields were increased slightly but not sufficiently to pay for the fertilizer applied. The highest yields resulted from the use of sheep manure, indicating that the high organic content of the soil increased the water-holding capacity and thus enabled the cotton plants to better withstand the drought conditions in August. For the 9-year period, 1928-1936, the yields of cotton were not sufficiently increased by the various fertilizer treatments to be profitable. The greatest increases came from the use of manure and acid phosphate. Nitrogen and potash were effective only in combination with phosphate.

The yields of corn this year, as in previous years, were not significantly increased by the various fertilizer treatments. The heavy treatments of 4-12-4 and the manure treatments lowered the yields slightly. Since results in each of the 9 years, 1928-1936, have been very similar, the use of commercial fertilizer, or manure, can not be recommended for corn on the heavy black lands of this region.

Wheat has responded to the use of commercial fertilizer much more definitely than corn or cotton, but the increased yield of one to five bushels has not been sufficient to pay for the fertilizer used. The use of manure has lowered the yields of wheat, because of the rank growth and severe lodging produced.

Legumes

A project, started in 1931, was designed to give definite information on the yield of seed and forage of a large number of legumes, and to determine those best adapted for forage and soil improvement in this region.

Because of wet weather during the fall of 1935, winter legumes were not planted until December 19, which was too late for the plants to become sufficiently well established to withstand the hard freezes of February and March. All varieties were replanted on February 2 and emerged to good stands on March 10. Dry weather in March and April prevented normal growth, and the yields are much below normal. Of the winter type legumes, Hairy vetch, Austrian Winter peas, and Tangier peas averaged approximately .75 ton forage per acre, which was considerably more than the yield of other winter legumes, such as Bur clover, Black Medic, Melilotus indica, and the true clovers. Among the legumes normally spring-planted, Yellow and White biennial Sweet clover, Hubam, Common and Turkestan alfalfa, and Laredo soy beans yielded approximately the same amount, .85 tons per acre. Brabham, the leading variety of cowpeas, made .49 ton forage per acre. Whippoorwill and New Era were next in order with yields of .39 and .38 ton per acre. Soy beans, as a group, yielded slightly more forage than cowpeas. Lespedeza sericea, the only variety of lespedeza surviving the spring drought, made a yield of .73 ton forage per acre.

In general, the bur clovers, Black Medic, Hairy Vetch, and Austrian Winter peas are the best legumes for fall planting. For spring planting, Sweet clover is the outstanding legume to use for general purpose on the black uplands of this region. Laredo or O-Too-Tan soy beans and Brabham or Whippoorwill cowpeas are recommended for late spring or early summer planting, when forage production or soil improvement are the main considerations.

Sweet Clover Method of Planting Test

This test was started in the spring of 1933 for the purpose of obtaining information on the production of sweet clover when planted in drilled, 18-inch row, and 36-inch row plats. This season first-year clover made .52 in drilled plats, .53 in 18-inch row plats, and .43 tons in 36-inch row plats. The second-year growth made .82 in drilled plats, 1.14 in 18-inch row plats, and 1.25 tons in 36-inch row plats.

For information on the effect of cutting sweet clover in its first year of growth, second-year growth, not cut in 1935, yielded 1.25 tons in drilled plats, 1.55 tons in 18-inch row plats, and 1.52 tons in 36-inch row plats. The 4-year average for these methods of planting indicates that sweet clover planted in 18-inch or 36-inch rows yields equally as well as clover drilled or broadcast, and will withstand extreme dry weather much better.

In order to obtain information on the amount of total forage produced and the grazing value for livestock, sweet clover and sudan grass were planted in alternate 18-inch and 36-inch rows for comparison with sudan planted alone and clover planted alone. In this test first-year sweet clover yielded .49 ton in alternate 18-inch rows and .33 in alternate 36-inch rows with sudan, while second-year growth of sweet clover yielded .86 in alternate 18-inch rows and 1.16 in alternate 36-inch rows with sudan. Sudan grass in alternate 18-inch rows with first year sweet clover yielded .33 and in alternate 36-inch rows .49 ton per acre. Sudan alone yielded .59 in drilled plats, .75 in 18-inch rows and .79 ton in 36-inch rows. The average yields in this test indicate that first-year sweet clover and sudan planted, either in alternate 18-inch rows or 36-inch rows, will yield more total forage per acre than either crop planted alone. Second-year sweet clover and sudan in alternate 18-inch or 36-inch rows is not satisfactory, because the early and rapid growth of sweet clover severely retards the growth of sudan.

Effect of Interplanting Sweet Clover on Yield of Oats. In this test oats planted alone yielded 49.2 bushels, while oats with clover drilled in at the rate of 15 pounds per acre yielded 36.1 bushels; oats with sweet clover in 18-inch rows yielded 32.8 bushels, and oats with sweet clover in 36-inch rows yielded 29.5 bushels per acre. While sweet clover planted in 36-inch rows in spring oats reduces the yield of oats slightly, this method of planting sweet clover is recommended for the black uplands of North Texas. Sweet clover planted in this manner usually makes good growth after the harvest of the oats and withstands hot, dry summer weather much better than when drilled or broadcast in the oats.

Soy Bean Rate and Date of Planting

A variety test of soy beans has been conducted at this station since 1923, and since 1931 Mammoth Yellow, Laredo, and O-Too-Tan have been grown regularly. The average yield of dry forage of these varieties was .92, .99 and .99 ton per acre, respectively. None of these varieties produced sufficient seed to be worth harvesting in any year during the test. Seed of Mammoth Yellow were harvested in 1931, making only 104 pounds, or approximately 2 bushels per acre.

This season this test was enlarged to include Mamredo, Mamotan, Biloxi, White Biloxi, Creole, Tokio, Ovoyelles, Delsta, Easy Cook,

Palmetto, Delnoshat, and Manchu in addition to the three varieties previously grown. For the early date of planting, Easy Cook and Mamredo made the highest yields of 1.55 and 1.03 tons forage per acre. Mammoth Yellow and White Biloxi made the lowest yields of .58 and .52 ton forage per acre. The remaining varieties yielded approximately the same. For the medium date of planting, Mamredo, Creole, Laredo, Delnoshat, Ovoyelles, Delsta, Mammoth Yellow, White Biloxi, and Mamotan yielded approximately .75 ton per acre. For the late date of planting, Delnoshat made the highest yield of 1.04 tons and White Biloxi, Manchu and Easy Cook made the lowest yields of .29, .52 and .69 ton per acre, respectively. The remaining varieties all yielded approximately .85 ton per acre. An average of the dates of planting shows Easy Cook, Delnoshat, Laredo, and Mamredo to be the leading varieties, and approximately equal in forage production.

None of the varieties, except Manchu, developed seed until after the rains the latter part of September, and, as a consequence, no seed matured before the killing frost on November 4, and seed yields could not be obtained. Manchu, a very early dwarf variety, set a good crop of seed which shattered badly before fully ripe. Judged from the standpoint of both seed and forage production under normal conditions, Mamredo, Mamotan, and Creole appear to be the most promising varieties for this territory. For forage production, Laredo and O-Too-Tan are still preferred.

Crop Rotation Studies

A special crop-rotation study, involving eleven different types of rotations, was started in the fall of 1930 for the purpose of determining just what types of crop rotation might be the most practical and economical on the Black Lands of North Texas. Since an experiment of this kind must run over a long period of years before definite conclusions can be reached, the results thus far are only indicative of what might be expected.

Cotton grown continuously on the same land for the past 6 years, cotton in a two-year rotation with Hegari, and cotton receiving 400 pounds per acre of 4-12-4 fertilizer yielded considerable below cotton in 9 different rotations, regardless of whether legumes were used for soil improvement or not. This fact indicates that rotation with corn or small grains is very important, and maintenance of production is largely a matter of maintaining or increasing the organic content of the soil and retarding or preventing the development of cotton root rot. Increases of 16 to 40 pounds of lint per acre were obtained from cotton in two-year, three-year and four-year rotations, the amount of increase depending somewhat upon the length of the rotation and the use of sweet clover or cowpeas a full year, or Austrian Winter peas as a fall and winter growing green manure crop.

Corn is not so dependent upon rotation as cotton, probably because moisture is more of a limiting factor and fertility in the soil cannot be utilized as fully. Corn is included in eleven different rotations and, thus far in the experiment, the type of rotation has had little influence on yield. In seasonable years, such as 1935, corn yields have been increased slightly in rotations in which sweet clover, cowpeas, or Austrian Winter peas have been included.

Wheat is grown only in a 4-year rotation of wheat-corn-oats-sweet clover, and continuously on the same land. This rotation has increased the yield of wheat slightly. Oats are grown in 4 rotations, and as a single continuous crop. Rotation has increased the yield of oats from 5 to 10 bushels, but the type of rotation has made very little difference.

Pasture Experiments

An experiment to determine the relative amount of pasture provided by small grains and rye grass through the winter and early spring, and to determine the effect upon yields when grazing was stopped February 15, March 1, and March 15 was completed this year. During the period, 1932-1934, oats and barley grazed from time of planting until February 15 produced almost twice as much forage as did the other grains. Wheat, rye, Italian and English rye grasses made approximately the same amount of forage during this period. For the period from March 15 to the end of the growing season, wheat and the two rye grasses made considerably more forage than did oats, barley, and rye. For the entire growing season, English rye grass and Italian rye grass yielded slightly more than wheat, and all three yielded approximately one-third more than oats, barley, or rye. Grazing wheat until March 1 increased grain production considerably. Grazing stopped February 15 was too early and subsequent rank growth tended to reduce yields. Grazing stopped March 15 was apparently too late, and injury to the rapidly growing plants resulted. Oats grazed until after early March freezes reduced freeze damage and increased grain production. Barley yields were neither increased nor decreased by grazing up to March 1, but grazing later than this reduced yields considerably.

Chemical analyses were made of the air dry forage from each of the clippings made during the entire season. It was found that the protein in the clippings made up to February 15 ranged from 30 to 34 per cent, while the clippings made after February 15 became progressively lower in protein as the season advanced, but not below 25 per cent. The small grains, wheat, oats, barley, and rye, differed very little in protein content, the average being about 27 per cent. The two rye grasses differed very little in protein content and averaged about 23.5 per cent. Oats and rye were slightly higher in fat than wheat and barley. Barley and wheat contained more ash than oats and rye. The two rye grasses were considerably higher in ash than the small grains.

Grasses: Dallis grass in its second year of growth made a yield of .74 ton per acre as compared with .95 ton for Italian rye grass and .78 ton for Rescue grass. Dallis grass in its third year of growth appeared to become sod-bound and made very poor growth during the season. Big Blue Stem and Little Blue Stem planted broadcast on thin grass land in the pasture failed to germinate. Buffalo grass sod planted 6 feet apart in thin native grass pasture by the Soil Conservation Service was almost completely killed by the extreme dry, hot weather of July and August. Sod that was planted in February and early March survived better than later plantings.

Inheritance of the Polled Character in Rambouillet Sheep

This project was started in 1930 for the purpose of assisting in the determination of the factor, or factors, involved in the inheritance of the polled character in Rambouillet sheep so that strains may be purified to the extent that horned males cease to appear. Since this project is carried under the direction of the Division of Range Animal Husbandry the results of this study are included in the report of that Division.

P. B. Dunkle.

SUBSTATION NO. 7, SPUR

Substation No. 7, Spur, is located one mile west of Spur, Dickens county, latitude 33 degrees north, longitude 100 degrees west, at an elevation of 2274 feet above sea level. Spur is located on the Rolling Plains of Texas, being 14 miles east of the escarpment known as the Cap Rock, which forms the line of division between the High Plains and the Rolling Plains of West Texas. The average annual rainfall for 26 years is 21.13 inches with annual extremes of 11.09 inches and 38.08 inches. The average length of growing season is 214 days. The station comprises 413.92 acres, of which 380 acres are in cultivation and the remainder in native grass pastures. The soils consist of Abilene and Miles clay loams and are characteristic of a large portion of the soils of northwest Texas.

The station is concerned with three principal lines of research: the development of profitable crop farming under conditions existing in the region; the utilization of feed crops grown in the section in the fattening of cattle and sheep; the prevention of runoff-water losses and soil erosion.

On account of a lack of subsoil moisture at the beginning of the season and a deficiency of rainfall during most of the growing season, all crop yields were low in 1936. Of the total rainfall for the year, 24.47 inches, 11.13 inches, or 45.5 per cent, fell during the month of September. Rains previous to this time were insufficient to carry cotton and

sorghum through a normal fruiting period, and the rains in September came too late to remedy the situation.

Cotton Experiments

Varieties of Cotton: The shortage of moisture during the summer months caused the bolls of all the cotton varieties to open prematurely. This largely accounts for the low yields and short staple. The highest yield was made by Mebane 141, a comparatively new strain that has shown excellent promise at this station in the four years that it has been grown. The yield of Mebane 141 was 129 pounds of lint cotton per acre. It ginned out 43.5 per cent lint that was $\frac{3}{4}$ inch in length. This strain was closely followed in yield by Westex, Missdel, D. P. L., and Half and Half. During a long period of years the Mebane strains and Half and Half have been the highest and most dependable yielding varieties. The longer length of staple produced by the Mebane strains has made them the more profitable cottons to grow.

Date of Planting Test: Over a span of 19 crop seasons plantings of cotton have been made at ten-day intervals from April 10 to July 10. The optimum planting date has varied greatly with seasons, but as an average of the whole period, plantings made at the middle of May have produced the highest yield. Planting dates in this region are determined to a large extent by soil moisture supply and rainfall near the planting. Earlier plantings are frequently made when soil moisture conditions are right for obtaining good stands. In other seasons planting may be deferred in anticipation of rains that will put the soil in condition for obtaining good stands. As a rule, however, plantings made earlier than the middle of May have a higher cost of production on account of additional cultivations required to kill weeds, and in addition, the crop frequently reaches the fruiting stage with soil moisture insufficient for normal fruit production. The yield and quality of later plantings are often cut short by early frost.

Spacing of Cotton: In the cotton rate of spacing test the distance between plants in 36-inch rows is increased by 3-inch intervals from 3 inches up to 33 inches. In 1936 the highest yield, 53 pounds of lint cotton per acre, was produced by the 21-inch spacing. Yields from the other spacings ranged from 26 to 43 pounds. Soil moisture conditions were such that the wider spacings made the highest yields. With favorable soil moisture conditions prevailing, the cotton plants have the ability to adjust themselves quite readily to either close or wide spacings; and over a period of 18 years the differences in yield from spacing between 9 and 24 inches have been small.

Method of Planting Cotton: The practice of plowing out or leaving unplanted every other row or every third row of cotton is widely used in some sections of West Texas. The data from the method of planting test at this station indicate that this practice, as it is generally put

into operation, merely gives a more nearly optimum stand than would obtain if all the rows were left in cotton. It appears, therefore, that if this method of planting is used, the main recommendation that may be made for its use is that it is a cheap method of thinning and reduces somewhat the amount of seed used in planting. In this test, however, the same number of plants per acre is left in each method of planting. The average yields of lint cotton per acre during the past five years are as follows: 36-inch rows, 198 pounds; 72-inch rows, 215 pounds; paired 36-inch rows, 179 pounds.

Cotton Cultivation: Different areas of cotton are given from one to seven cultivations at intervals of two weeks. The highest yield was produced in 1936 on the area that received only one cultivation. Over a period of 14 years two cultivations have produced the highest yield. The number of cultivations required to produce the best results varies with the seasons. In general, it may be said that cultivations above the number needed to kill weed growth do not produce increases in yield and in most cases cause a decrease in yield. The harmful effect of continued late cultivation of cotton becomes almost immediately evident as indicated by wilting of plants and later by shedding of flowers and fruit. A study of the cotton root system shows how this harmful effect is produced. The largest lateral roots of the cotton plants spread across the rows at a depth of three to six inches below the soil surface. It is therefore evident that even shallow cultivation will cut some of these roots, thus decreasing the plant's facilities for taking moisture and plant food from the soil.

Grain Sorghum Experiments

Grain Sorghum Varieties: Plantings of 23 varieties of grain sorghum were made on May 12 and June 2. The early plantings suffered severely for moisture during the fruiting season and made rather low yields. These yields were further decreased for some of the later maturing varieties by rain damage in September. The later planting was killed by frost before grain was matured. Early Yellow milo made the highest yield, 11.2 bushels of grain per acre, followed by dwarf Early Yellow milo with 9.7 bushels, and Dwarf Yellow milo with 9.0 bushels. Over a period of years the highest yielding varieties have been Dwarf Yellow milo, Spur feterita, Texas Blackhul kafir, and Hegari.

Planting Date of Milo: In this test, which has been in progress 19 years, Dwarf Yellow milo is planted on the 10th, 20th and 30th of each month from April 10 to July 10. During this period plantings of milo made the last part of May or the first part of June have shown the highest average yield of grain. The yields from the different planting dates, however, have varied greatly from year to year and have been influenced largely by soil moisture.

Plant Spacing of Milo: In this test the spacing between plants of Dwarf Yellow milo in 36-inch rows is increased by 3-inch intervals from

3 inches up to 33 inches. The wider spacings made the highest yields in 1936 because there was an insufficient supply of soil moisture to sustain growth on the closer spacings. During a period of 15 years the spacing of 18 inches has given the highest yield, closely followed by the 15-inch spacing.

Method of Planting Milo: As an average of 14 years, where the same number of plants per acre was used for each method, the difference in yield of Dwarf Yellow milo planted in 36-inch rows, 72-inch rows, and paired 36-inch rows has been insignificant. A procedure that has been found to be practical and economical is to plant all rows and then, when the plants are 6 to 8 inches high, plow out every second or third row if the stand and soil moisture conditions warrant this.

Milo Cultivation Test: Different areas of Dwarf Yellow milo are given from one to seven cultivations at intervals of two weeks. The results from this test are almost identical with those obtained from the cotton test previously discussed. The highest yield in 1936 was obtained from the area that received one cultivation, and the highest average over a period of years was obtained from the areas receiving two cultivations.

R. E. Dickson, B. C. Langley.

Soil and Water Conservation Studies

(In Cooperation with Soil Conservation Service,
U. S. Department of Agriculture.)

The experiments at this station relate particularly to the Southern Great Plains area. This project has been under way for 11 years and has for its purpose the study of the factors influencing runoff-water losses and soil erosion and the effect of water and soil conservation practices on crop production. The factors contributing to runoff-water and soil losses are studied on control plats of $1/75$ acre in area. The efficiency of different terracing systems and other obstructions and of different crops in preventing water and soil losses is studied on field areas varying in size from 6 to 120 acres.

Control Plats: The rainfall in 1936 was 24.37 inches, which is 3.28 inches above the 26-year mean. During the 11 years that this experiment has been in progress, the rainfall has been above the long time average 4 years and below 7 years. The average for the 11 years, however, is only .33 inch below the average for 26 years. The rainfall, therefore, during this period is fairly representative of the amount and distribution that may be expected in this region. This year was characterized by moderate to low rainfall in 11 months and an all-time monthly high of 11.13 inches in September. Water and soil losses were low during the year except in September. As the result of a rain of 3.19 inches on September 21 a fallow plat with 2 per cent slope lost 90 per cent of the water that fell, and a cotton plat with the same slope lost 47 per cent. This rain was torrential in nature and followed a prolonged

rainy season. Torrential rains are a common occurrence in this region, and measures of control are necessary to save this much-needed water for use in crop production. Although rapidity of rainfall plays an important part in determining the extent of water and soil losses, there are other factors which exert a considerable influence. That water and soil losses are greatly influenced by the physical condition of the soil and by the vegetative cover, both living and dead, is unmistakably evident. The following treatments are given in order of their effectiveness in preventing both water and soil losses: buffalo grass, milo, cotton, cultivated fallow, uncultivated fallow.

Field Areas: Various conservation practices as put into effect on areas of 6 to 10 acres in size show that crop yields have been consistently increased as the amount of water available for plant use was increased. Seasonal rainfall, although it is a highly significant factor in determining crop yields, is not sufficient alone to produce normal yields. Pre-seasonal rainfall that has been stored in the soil is necessary to supplement the seasonal rainfall. Any conservation measure which increases this amount of soil moisture reduces in proportion the risk involved in crop production. The effectiveness of certain measures of control in reducing the loss of water from crop land and in increasing yields is shown by the following data which are an average of the period 1927-1936:

Treatment	Inches water lost	Inches water added	Yield, lbs. lint cotton per acre
Terraces sloping 3 inches per 100 feet.....	2.18		154
Contoured rows, no terraces.....	1.36		186
Level terraces, ends open.....	.73		211
Level terraces, ends closed.....	0		257
Level terraces, ends closed, waste water added		2.64	274

Syrup Pan Terrace System: For 6 years the runoff-water from a 1200-acre watershed adjoining the station has been diverted to a 120-acre tract of cultivated land that has a system of level terraces with alternate ends open for conducting the water back and forth across the field as it flows toward the lower end. This device has been designated as the "syrup pan" system of terraces, and the tract as a whole is referred to as the "water trap." During 6 years 17 rains have caused water to flow onto this tract, and all of them have supplied enough water to flood the upper 56 acres. Only four of these rains, however, supplied enough water to flood the entire 120 acres. The water available for crop production has been increased 24.4 per cent on the upper 56 acres and 13.8 per cent on the lower 64 acres. In several of the years during the period this additional water has meant the difference between fair to excellent crops and crop failure. This benefit was evident in 1936 when a field of cotton in the flooded area that received 2.73 inches of flood water during the growing season produced 146 pounds of lint

cotton per acre, while adjacent land on which all the rain water was held but which received no flood water produced only 39 pounds per acre. From rains amounting to 4.87 inches which fell in the last few days of September, 5.67 inches of water were added to this land, or the effective rainfall was more than doubled during this rain period. The water diverted to the water trap in the latter part of September and the accompanying rains came too late to be of benefit to the current year's crop. It has been stored in the soil, however, and will be available to supplement the rainfall during the 1937 crop season.

The above data emphasize the practicality and the importance of conserving rainfall as it falls so that it may be used later to bridge over the frequent drouthy seasons.

Pasture Improvement Studies: The pasture improvement studies have included several operations: Solid listing on contours, grubbing mesquite brush and prickly pear, building terraces, diverting waste water to pasture land from adjacent highways, mowing weeds, and manuring.

The vegetation on the pasture land used in these studies was predominantly buffalo grass (*Buchloe dactyloides*) with a few plants of *Bouteloua* and *Stipa* species. Observational plats were solid listed on contours in May, 1932. The land was listed at 39-inch intervals to a depth of 3 inches. In this procedure all the grass is not covered, since a fringe of grass is left exposed along the edges of the lister furrows. This fringe of grass is sufficient to cover later the lister beds and furrows. No yield data were obtained from the plats listed in 1932, but estimates of the increase in grass production and carrying capacity have been substantiated by later studies. Additional pasture land was listed in May of 1934 and 1936. Harvesting data were obtained in 1935 and 1936 from the land listed in 1934. The average yield for the two years was 2369 pounds of dry grass per acre as compared with an average of 725 pounds from unlisted land. Land listed in 1936 produced 1326 pounds of dry grass in that year as compared with 592 pounds from unlisted land. Steers pastured on these areas have given a return in increased weight valued at \$7.15 per acre for the year.

Soil moisture determinations made on October 17, 1936, following 11.13 inches of rain in September, showed a penetration of water to a depth of 72 inches on the contour listed land and an available moisture supply in the soil of 6.67 inches. On the unlisted land the depth of penetration was 30 inches and the available moisture only 2.10 inches. The yield of grass on both areas that was produced by heavy rains in September was approximately 20 per cent of the total yield.

Sections of soil 15 inches square and 6 inches thick were removed to a depth of 66 inches on both the listed and unlisted areas. The grass roots were washed from the soil and the root volume determined by water displacement. In the samples taken from land listed in 1934

there were 594 cubic centimeters of roots, and in the samples from unlisted land there were 363 cubic centimeters. The root system has thus been increased 64 per cent by contour listing.

Buffalo Grass Selections: Forty-four staminate and forty-four pistillate plants of buffalo grass (*Buchloe dactyloides*) were obtained in 5-inch sods and set in plats 5 feet square on May 15, 1934. A thorough watering was given the plants at the time they were set out. The grass grew very rapidly, and by midsummer of 1935 had covered the 25 square feet allotted to each plant. The selections have shown great variation in character, color, and amount of foliage, seed production and seasonal growth. The highest yield of any one plat in 1936 was at the rate of 5.4 tons of dry grass per acre and the lowest 1.7 tons. These plats receive runoff water from a nearby roadway during storm periods and thus have a larger supply of water than would be the case under range conditions.

The root system under one of the buffalo grass plats was removed by washing away the soil with water. The system was a mass of fibrous, interlacing roots and rootlets extending to a depth of 6 to 7 feet. Determinations revealed that there was approximately three-fourths of a mile of roots under one square foot of the grass.

The variation exhibited by these different grass plants emphasizes the opportunity that exists for improving native pasture plants by selection.

R. E. Dickson, B. C. Langley, C. E. Fisher, S.C.S.

Vitamin A Requirements of Yearling Steers

(In Cooperation with the Bureau of Animal Industry,
U. S. Department of Agriculture.)

A project designed to carry on in more detail the previous investigations pertaining to the vitamin A requirements of beef cattle was inaugurated at this station during the past year, and entered into by the Division of Range Animal Husbandry, Veterinary Science and Chemistry.

A group of good 560-pound yearling Hereford steers was depleted of vitamin A storage on a ration of 90 per cent cottonseed hulls and 10 per cent cottonseed meal and later changed to 85 per cent hulls and 15 per cent meal. As the cattle became depleted they were placed on rations furnishing from 200 to 2400 micrograms of carotene per hundred pounds live weight supplied in the form of alfalfa hay meal.

The first symptoms of vitamin A deficiency became manifest in 114 days although one steer resisted the effects of the deficiency ration for 267 days and another continued on the deficiency ration throughout the entire test—a period of 380 days. The deficiency is manifested in the form of night-blindness, swollen and watering eyes, nasal discharge, slobbering, stiffness, swelling of the joints, loss in weight, and in more

advanced cases, staggering gait, total day-blindness, fainting and falling to the ground, and eventually death.

The following results have been obtained from the work conducted with yearling steers during the past year:

- (1) 200 and 350 micrograms of carotene per hundred pounds live weight were not sufficient to correct night-blindness nor to enable the cattle to make reasonable gains. Three steers started on 200 micrograms and one steer started on 350 micrograms became so depleted that they developed complete day-blindness.
- (2) 500 micrograms appears to be a little short of the amount required to prevent night-blindness in cattle. Five steers fed 500 micrograms of carotene per hundredweight after becoming completely night-blind failed to improve in eye-sight at night, and three of the five became completely day-blind.
- (3) Depleted steers, when started on 750 micrograms and 2400 micrograms of carotene per hundred pounds live weight, improved in night vision immediately, while there was no improvement in groups receiving 500, 350, and 200 micrograms.

Results thus far indicate that more than 500 micrograms and possibly less than 750 micrograms of carotene per hundred pounds live weight are required to control night-blindness. There is some indication that the requirement for gain in weight is less than the requirement for vision.

The fact that some steers require a longer depletion period than others indicates that different individuals may vary in ability to store up vitamin A and carotene. The steer which withstood the deficiency ration for 380 days made fair to good gains, acquired a nice finish and topped the Fort Worth market along with other cattle of the group, but was condemned on the killing floor for polyarthritis. Two other carcasses from this lot of deficiency steers proved faulty, and one was from a day-blind steer fed on 500 micrograms of carotene.

Liver analyses on cattle fed on a ration of silage, cottonseed meal, and cottonseed oil indicate that there is an ample supply of carotene available from silage.

Extensive chemical and histological studies are being carried on by the Division of Veterinary Science at the Main Station with regard to livers, eyes, and brains of the deficiency cattle. Results of this work will be found under the Division of Veterinary Science.

R. E. Dickson, J. H. Jones, John K. Riggs.

SUBSTATION NO. 8, LUBBOCK

Substation No. 8 is located three miles east of Lubbock, Lubbock county; latitude 38 degrees and 37 minutes north, longitude 101 degrees

and 45 minutes west; elevation 3215 feet above sea level. The average annual rainfall over a period of 26 years was 18.93 inches, with yearly extremes of 8.73 and 31.88 inches. The Station comprises 160 acres of land, 152 in cultivation and the remainder in pasture. The soil is of the Amarillo and Richfield fine sandy loam type, which is typical of a great portion of the region.

The Station is the only one located on the High Plains region of Texas in a new agricultural section of the State. The principal objectives are: the introduction, breeding, and improvement of the grain and forage sorghums which have been found to be the basic agricultural crops of the region; the breeding and improvement of varieties of cottons adapted to high altitude, limited moisture, and mechanical harvesting; the determination of the best method of soil management and crop treatment in the region; and the collection of reliable information on fruit and truck crops, shade and ornamental trees and shrubs, legumes, and other plants essential to a well-rounded-out agricultural program.

Grain Sorghum Experiments

Grain Sorghum Varieties: The principal varieties of grain sorghums grown in this region are milo, kafir, and Hegari. Bulletin No. 459, "Grain Sorghum Varieties in Texas" covers the work at this Station for the period 1912-1931. Beginning in 1932 a large number of new varieties, largely of hybrid parentage, have been grown in comparison with milo, kafir, and Hegari. The new varieties are made up of sorghums created especially for combine harvesting, extreme earliness, and bundle-feeding. On account of the deficiency in rainfall the past several years the extremely early varieties have made the best yields, and an increasing acreage is being planted to them in this region.

Hegari in Paired Rows: Hegari planted in normal spaced rows with 12-inch plant spacing has averaged 15.9 bushels to the acre for the past three years as compared to 16.1 for paired rows. Under the same conditions the forage yields have been 2.04 and 1.85 tons.

Where 8-inch spacing was used in the paired rows, producing the same number of plants as in the normal-spaced rows, yields were 14.7 bushels to the acre in normal spacing and 12.8 in paired. Under the same conditions the forage averaged 1.90 and 1.74 tons per acre.

Grain Sorghum Improvement: A breeding project with sorghums has been carried on for a number of years with the aim of producing sorghum varieties or strains that would better serve the region. The specific object was to obtain varieties that would be dependable during the recurring years of subnormal rainfall and disease-resistance, and produce economies in harvesting. A strain of Early Yellow milo, developed and distributed by this Station has produced very satisfactory yields during the past dry years; strains of Dwarf Yellow milo resistant

to a disease known as "Milo disease" or "Milo Blight," are being increased for distribution to farmers. A number of selections from milo-kafir and milo-Hegari crosses which have yellow seed and erect heads are about ready for distribution for use as both grain and bundle feed.

Cotton Experiments

Cotton Varieties: Eighteen varieties of cotton were grown in 1936, ranging in staple length from $5/8$ to $1\ 1/32$ inches. June, July, and August rainfall was only 34 per cent of normal. Yields consequently were low, averaging 163 pounds of lint per acre. For the past eight years, Half and Half, with an average yield of 257 pounds of lint per acre, has been the highest and Ferguson 406 the next highest. Half and Half will probably remain the most popular variety, even with its short length, unless a greater yield can be obtained from the better staple varieties or a larger price spread between the shorter and longer staple lengths is maintained.

Treatment of Cotton Seed: In a comparison between fuzzy and delinted seed, both planted at the rate of 20 pounds per acre, there was no significant difference either in the rate of germination or total germination for the season of 1936. Actually there were 24 per cent more seed planted on the delinted plats than on the fuzzy.

Delinted seed planted at the rate of 20 pounds per acre compared with delinted seed treated with Ceresan at the rate of 2 ounces per bushel of seed indicated slightly better results this season where the seed were untreated. Treating fuzzy seed with Ceresan did not increase either the rate or total germination.

Delinted seed planted at the rate of 10 pounds per acre produced an average of one plant every three inches. Where the press wheel was used, emergence was at a slightly accelerated rate.

There was no difference in total germination where delinted seed was covered 1 and 2 inches, but where covered only 1 inch germination was at a slightly more rapid rate. The use of Ceresan on both delinted and fuzzy seed reduced yields.

Cotton Breeding: To date, the cotton improvement program at this Station has centered around pure-lining various strains and varieties with outstanding characteristics desirable in a cotton for this area. So far, selection work has shown none of these varieties or strains to be outstanding enough to supplant those already being grown. A number of crosses made in an effort to combine some of these desirable qualities are now in the F_2 and F_3 and have shown considerable ability from the standpoint of earliness, length of fiber, and storm resistance. Further selections to increase lint turn-out are being made.

Cotton Row Spacing: For the past four years normal row spacing with a plant spacing of 12 inches has averaged 128 pounds of lint compared to 116 in paired rows. As total rainfall has been deficient in three out of the four years and deficient during the growing period for all four years, it is doubtful if this practice is feasible in this area.

Small Grain Pastures: Barley, oats, wheat, and rye are sown in small plats for a winter pasture test. Usually, barley and oats are either winter-killed or stunted to such an extent that yields are reduced. Barley, on account of its exceedingly fast growth in the fall and early winter, affords considerable pasturage, and indications are that a combination seeding of barley and rye will give the greatest amount of pasture for this section as the rye usually produces its heaviest tonnage the last half of the season.

Horticultural Experiments: Eight years' results with grapes under dry-land conditions indicate an average yield of some 5 pounds per vine for the better adapted varieties. In favorable years yields of 25 pounds per vine may be expected. Fern Munson, Beacon, Cloeta, Edna, and Wapanuka are some of the better-yielding varieties.

Date and Method of Preparing Seed Bed: The seed bed is prepared in January, April, and at planting time. For the duration of the experiment there is little or no choice between January and April, but both of these dates are greatly superior to May. Seven-inch prepared seed bed is slightly better than $3\frac{1}{2}$ and there is little difference between plowing and listing as a method.

Soil Fertility and Moisture Conservation: Forty-two $\frac{1}{10}$ -acre plats are devoted to a study to determine the effect of continuous cropping, fallow, crop rotation, manuring with barnyard and green manure, on crop production and soil moisture. Cotton and grain sorghums are the crops grown, with Sorgo being used for green manure. For a period of 22 years cotton alternated with fallow, cotton continuously fertilized, cotton manured after fallow after grain sorghum, cotton after fallow manured after grain sorghum have been the highest-yielding rotations. It is significant that fallow enters into three of the rotations as the preceding crop. However, the difference in yields between the other rotations such as continuous cotton are so slight that as a practice it is not profitable.

Where grain sorghums are cropped, the three highest rotations over the same period of years show that best results are obtained where fallow is the previous crop, but again the difference between these rotations and continuous cropping is slight.

Cotton and Grain Sorghum Fertilized: Where application of 100 pounds of sulphate of ammonia is applied to both cotton and grain sorghums no difference has been found in yields as compared to non-fertilized plats.

Plats receiving no fertilizer were compared with those receiving 2, 4, and 8 tons of barnyard fertilizer and one receiving 2 tons of cotton burrs per acre. During the past two years moisture conditions have been subnormal, and while differences in yield are rather slight, indications are that the plats receiving 2 and 4 tons per acre are superior to those receiving 8 tons and the one receiving 2 tons of cotton burrs. The plats receiving the heavier application of barnyard fertilizer have had a greater per cent of their cotton open at the first picking than those plats receiving no fertilizer or the light application of 2 tons per acre.

D. L. Jones.

Storing Pork in West Texas: In this test, conducted in cooperation with the Division of Swine Husbandry, and the Texas Extension Service, hams and bacons receiving the same treatment as to cure and smoke were stored in the fall of 1935 in crude cotton seed, refined cotton seed, soy bean, peanut, and mineral oils. This meat was compared with hams and bacons stored in air-slaked lime. At the end of ten months all meat was taken out of storage and weighed. The meats stored in oil showed practically no shrink and no mould, while those stored in air-slaked lime had heavy mould and from 15 to 20 per cent shrink.

The ham stored in crude cotton seed oil had a slight cotton seed flavor, while with the bacon this flavor was rather pronounced. There was no foreign taste to any of the hams in the other oils but there was a slight foreign flavor to the bacons, indicating that the fat meat may have absorbed some of the oil.

Fred Hale, R. W. Snyder, D. L. Jones.

Cotton and Grain Sorghum Under Pump Irrigation: An experiment to determine the total amount of irrigation water necessary to produce maximum yields and its date of application was started in 1936. Due to difficulties in completing the well, the pre-planting irrigation took place May 2 instead of one in February and one in April as had been planned. Plats receiving no irrigation averaged 5.6 bushels of grain per acre as compared to 11.2 for those receiving an irrigation before planting, 27.2 where irrigations took place May 2 and July 14, and 32.0 bushels where the irrigation was done May 2, July 14, and August 10. All applications were at the rate of a 3-acre-inches per irrigation. Due to the extreme heat of August and the drouth of the three summer growing months when the natural rainfall was only 34 per cent of normal, all yields were disappointing.

Where no irrigation water was applied, cotton averaged 148 pounds of lint per acre as compared to 212 where the land was irrigated before planting, May 2; 272 where it received one pre-planting and one irrigation on July 14; and 500 pounds where one pre-planting as well as two post-planting irrigations, on July 14 and August 10. An extremely heavy infestation of flea hoppers in August combined with the subnormal rainfall and excessive temperatures undoubtedly curtailed yields.

D. L. Jones, Frank Gaines.

Cooperative Nursery: The Texas Forest Service during the past year has entered into a new cooperative project with this Station for further expansion of forest nursery testing and distribution of desirable species. The U. S. Forest Service has also joined in the support of this project through funds available from the Clark-McNary act.

Trees suitable for windbreak, woodlot, and shelterbelt and general farm plantings are grown and distributed at a nominal charge to farmers.

As this was the first season, only a nominal number of Red Cedar seedlings were available. By 1938 Red Cedar (*J. virginiana*), *P. ponderosa*, *P. nigra*, *P. sylvestris*, *P. edulis*, will be available.

Approximately 70,000 hardwoods, comprising Chinese elm, Honey locust, Osage-orange, Black walnut, Red Bud, Tamarix, and Flowering Willow were distributed during 1936-1937.

D. L. Jones, U. A. Randolph.

SUBSTATION NO. 9, BALMORHEA

Substation No. 9 is located adjacent to the O.S.T. Highway approximately four miles east of Balmorhea. The Madera Valley, in which the Station is located, and also surrounding ranch country, is served by the Pecos Valley Southern Railroad, a branch of the T. & P. Railway.

The elevation at the Station is approximately 3200 feet, the latitude 31 degrees north, and the longitude 103 degrees west. The annual precipitation is very variable but is never sufficient to produce staple crops without irrigation. Average precipitation for the past 14 years has been 13.92 inches with a maximum of 28.15 inches and a minimum of 3.89 inches. The annual average evaporation is 63.6 inches and this high rate makes it necessary to use large quantities of irrigation water for production of crops. Irrigation water is obtained principally from flowing springs, but this is supplemented by flood water from the Davis Mountains.

The work of this Substation deals with the problems connected with the production of irrigated crops, the development of better-balanced farming systems, and more attractive living conditions in the irrigated sections of Western Texas. During the past few years this work has included the development of a feeding system which would make it possible to fatten livestock here with a minimum amount of grain and a maximum amount of the roughages grown in abundance locally.

Cattle Feeding Investigations

Cattle feeding work at Balmorhea has for its main object the development of a feeding system by which cattle may be fattened with a minimum amount of grain and a maximum amount of roughage, such as alfalfa

and Hegari fodder, which is produced in abundance in these irrigated valleys. Work to date has shown that cattle may be finished for market with a much higher proportion of roughage and much less concentrates than generally used in feeding practices. Four lots of steers finished on high roughage rations in 1935 and 1936 required only one-half as much total concentrates per 100 pounds of gain as four other lots full-fed during the same years. Final finish was about the same for all lots but a six weeks' longer feeding period was required for the steers receiving the limited grain ration to reach approximately the same degree of finish as those full-fed. Average daily gains of the lots fed limited grain rations were 13 per cent lower than those full-fed but the total gain was greater because of the longer feeding period. Rations consisted of ground hegari fodder, cottonseed meal, a small amount of cottonseed, and ground threshed milo. Alfalfa hay was added during the last six weeks and the milo was fed during the last six to ten weeks, or after the steers had reached the point where more concentrated rations were needed to put on the final finish. This method of feeding should prove profitable in irrigated areas producing large amounts of roughage in proportion to grain.

Agronomic Work

Agronomic work has dealt principally with the staple crops, alfalfa, cotton, sorghums, and miscellaneous legume crops.

The Acala variety of cotton has proved to be the best variety for general planting. Under irrigation the best strains of Acala have all made good yields with an average length of staple of 1 1-32 inches. Half and Half has produced a little more lint per acre but length of staple has averaged only 25/32 inches. Lankart, Mebane, Kasch, and many other varieties have been late in opening when grown under irrigation here. Stoneville strains have made high yields under conditions where Acala is likely to produce too much vegetative growth.

Applications of various fertilizers have shown that sulphur, potash, and lime have no influence on yields of staple crops here. Nitrogenous fertilizers have usually given increased yields of cotton on fields not recently in alfalfa. Superphosphate has had little effect upon the yield of cotton on these soils, but has increased yields of alfalfa to some extent.

In sorghum variety tests milo has been the best strictly grain sorghum but Hegari produces nearly as much grain and a heavy tonnage of forage of excellent quality. Ground Hegari fodder with the heads has made up a large part of the ration in feeding tests and has given excellent results. Sumac is the best forage sorghum. Since birds damage grain sorghums in the field before harvest and also after the crop is in the shock, it has been found that a great deal of protection is afforded by mixing about 10 per cent Schrock kafir seed with Hegari seed at

time of planting. When the crop is put in the shock the taller Schrock kafir heads protect the Hegari heads. Sumac would serve the same purpose.

Legume Crops

Several years' work with miscellaneous varieties of legumes has shown that varieties of lespedeza, clover, vetches, and most other legumes are of little value under climatic conditions here. Biennial Sweet Clover, Hubam, and Alfalfa are well adapted. Soybeans and cowpeas make only fair crops and are of little economic value where alfalfa may be grown so easily. Sesbania is naturally inoculated with nodule-forming bacteria but soybeans, cowpeas, and many other legumes do not produce many nodules on the roots unless inoculated and supplied with an abundance of water.

Fruit Adaptability Trials

Since soil and climatic conditions in this section are not especially favorable to the development of an extensive fruit growing industry, the planting of such material should be largely for home use. The principal handicaps to commercial fruit growing are late spring frosts, low humidity, high summer temperatures, and cotton root rot which kills out non-resistant varieties before they reach the bearing age. Home orchards should be planted only on soils known to be free from the root rot fungus. Peaches, plums, pears, apricots, jujubes, and pecans are among the best of the tree fruits for growing on land free from cotton root rot. Apples do well in the higher altitudes of the Davis Mountains but are not well adapted to the lower plains section.

Although this section is not especially well adapted to the commercial production of fruit, every farm should have at least a few trees of the best adapted varieties.

Vineyard Management

A rather extensive vineyard, including most of the varieties commonly grown, was established on the Station during the years from 1924 to 1930. Hardy adapted varieties have survived while many of the less hardy have died out. Root rot is the principal disease affecting grapes and the Champanel, Black Spanish, and Mustang have shown the most resistance to this disease. The grape leaf hopper and the Green May beetle have been the most serious insect pests. Low humidity and high summer temperatures have been more favorable for Vinifera varieties than for American varieties. Thompson seedless and Rose of Peru are two of the best vinifera varieties for home use. Muscat lacks vigor of growth but yields well some years. Tokay, Mission, Cornichon, and

Alicante Bouschet are fairly well adapted. The Last Rose, Herbeumont, Edna, Champanel, and Black Spanish have been among the few American varieties which could withstand the dry atmosphere and low humidity. The foliage of most American varieties is badly burned during midsummer. The Champanel has continued almost free from damage by leaf hoppers due to the hairy under-surface of the leaves.

Ornamental Adaptability Trials

Because of the low humidity of this section and high temperatures which prevail during the summer months, the number of varieties of ornamentals which are really adapted to Western Texas is rather limited. This is especially true of the broad-leaved shade trees. In order to determine more definitely what varieties of ornamentals were adapted here, rather extensive trials have been carried on at this Station to obtain information regarding their growth, hardiness, and general adaptability to local conditions.

The most unfavorable conditions which restrict the growing of ornamentals are: high summer temperatures, low winter temperatures, low humidity, and cotton root rot in many soils.

As a class the hardy varieties of Coniferous evergreens have been among the best adapted ornamentals. Some of the varieties which have been grown most successfully over a period of years are as follows: Red Cedar, Pfitzer's juniper, Arizona cypress, Live oak, Italian cypress, and Baker's, Ramsey's Hybrid, Berkman's Golden, Bonita, Blue Green, Gold Spire, Texas Blue, Golden Column, Pyramidal, and Chinese arborvitae. The Japanese climbing and bush honeysuckles, flowering pomegranate, flowering willow, Euonymous, Arizona ash, Jujube, Ulmus parvifolia, privets, Black locust, Radiance roses, Rugosa rose, and Pampas grass have all made a good showing under these conditions.

On soils which are not infected with cotton root rot the Chinese elm, Cottonwoods, and Russian olive have made a rapid growth, but these varieties are very susceptible to attacks by this disease.

J. J. Bayles.

SUBSTATION NO. 10, FEEDING AND BREEDING STATION

Substation No. 10 is located at College Station, Brazos county, one mile northwest of the College on the public highway; its latitude is 30 degrees north and its longitude 96 degrees west; it is 308 feet above sea-level. The annual average rainfall over a period of 40 years was 38.02 inches. The land owned and assigned to the Feeding and Breeding Station comprises 920.8 acres.

The work of this station embraces investigations in the feeding, breeding, and management of swine, dairy cattle, poultry, goats, and sheep.

Progress of work on projects with these animals is treated elsewhere in this report under the respective divisions concerned.

Of the land embraced in this station, approximately 1550 acres are in cultivated crops, 200 acres in improved pasture, and the remaining 570.8 acres in native pasture.

SUBSTATION NO. 11, NACOGDOCHES

Substation No. 11 is located two and three-fourth miles north of Nacogdoches, Nacogdoches county, on State Highway No. 35; its latitude is 32 degrees north and its longitude 94 degrees west; its elevation is 292 feet above sea-level. The average annual rainfall over a period of 24 years was 49.07 inches. During this period an average of 15.95 inches, or 32.50 per cent of the total average annual rainfall, occurred during the months of May, June, July, and August, but this year 13.34 inches has fallen during these months. The average length of growing season during a 23-year period is 249 days, with the average last killing frost in the spring occurring March 12, and the average first killing frost in the fall occurring November 16. The purpose of this station is to serve the region of Texas in which the Nacogdoches soils, or "Redlands," occur. The redlands of the Nacogdoches soil series were among the earliest-settled farm lands in the State. This soil in the virgin state is productive, but since much of it has been in cultivation for a long time, one of the chief problems of the station is that of finding the most effective and the most practicable systems of cropping for building up and maintaining soil fertility; other studies concern the use of fertilizers, including rate and time of application, and the development of horticultural and agronomic crops suited to a diversified agricultural program for this region.

Soil Improvement Investigations

Preliminary Studies of Artificial Plats for Field Experiments

In accordance with the proposed revision of all soil fertility studies at this station, the use of artificial concrete tank plats was continued in order to test further their reliability for use in field experiments. Three series of tanks, consisting of twenty 1/1000 acre plats each, are available for this work.

Because of continued loss of plants from Fusarium wilt, former studies on cotton and tomatoes were abandoned in favor of Sudan, a grass crop which was not susceptible to this disease.

Nine fertilizer treatments and one soil check were used in connection with the planting of the Sudan grass, each treatment being replicated six times. A summary of the yields of dry forage from these treatments shows an increase from their use in every instance over

that of the unfertilized area. A definite and consistent increase was obtained where the amount of a 4-8-4 fertilizer was increased from 200 to 400 and 600 pounds per acre. Nitrogen is apparently the main plant food required as varying amounts from none to eight per cent produced consistent increases of dry forage. Varying results were had from the different rates of phosphoric acid applied. Potash treatments showed little influence on the amount of plant growth.

Fertilizer and Seed Treatment Studies

The cooperative project with the Division of Agricultural Engineering, the Bureau of Agricultural Engineering of the U. S. Department of Agriculture, wherein the placement of commercial fertilizer in respect to its position with the cotton seed was being studied, was terminated at the close of the 1935 season. During the 1936 season new studies were begun on the effect of disturbing the seed bed when applying fertilizer at different positions in relation to the cotton seed. A further cooperative study on the use of fungicides on cotton seed prior to planting was also inaugurated this season. The results of both studies are reported fully in the report of the Division of Agricultural Engineering.

Agronomic Investigations—Cotton Varieties

The results obtained during the last 20 years, 1912 to 1931 inclusive, indicate that Acala, Truitt, Lone Star, New Boykin, Kasch, and Ferguson 406 are the most desirable varieties for this region. Conclusive summaries of cotton varietal characters and yields are to be found in Texas Station Bulletin No. 84, "Varieties of Cotton for Central East Texas," which covers the years 1921 to 1927 inclusive. In continued studies on cotton varieties for East Texas, results of this season show that Half and Half, New Boykin, Acala, and Lone Star matured their crop in the named order. Half and Half continued to produce the highest yields of lint per acre, the highest per cent of lint, the smallest boll, and the shortest staple. Acala produced the longest staple length, with Lone Star, New Boykin, and Half and Half following in the order named. Yields obtained this season show Half and Half, New Boykin, Acala, and Lone Star producing 170, 154, 132, and 110 pounds of lint cotton per acre, in the order named. A summary of a five-year test on the yield of lint of these varieties shows yields of Half and Half 218, New Boykin 185, Acala 171, and Lone Star 114 pounds per acre.

Cotton Breeding

In a continuation of the cotton breeding work of this station, sixty-three progeny rows of plant selections from the 1935 F_5 progeny rows,

and their parents, were grown. These selections were from strains of a cross of Half and Half x Lone Star made by D. T. Killough, Cotton Breeder, Division of Agronomy. Within these sixty-three progeny rows, three plants of desirable type were selected per row for inbreeding purposes, eight to twelve selfed bolls per plant being obtained. Each individual plant was harvested separately for further laboratory selection of these inbred plants for planting during the 1937 season. A planting for increase during 1937 was made of sixty-seven progeny rows from individual open pollinated selected plants from best progeny rows grown during 1935. Ten individual plants were selected and harvested for further laboratory analysis as to length, per cent, and yield of staple. One lock samples were taken from each individual plant in all of the progeny rows for laboratory analysis in order to have a comparative standard for making the field selections.

During 1935 a number of the F_5 inbred selections from the Half and Half x Lone Star Cross were back-crossed on the Half and Half parent and from this material eighteen selections of the F_1 back-cross were grown during 1936. Eleven of these selections were further used for back-crossing on Half and Half during the 1936 season, with ample seed being obtained from both the back-crosses and selfs made. Additional initial crosses and selfs were made during the season on selfed plants of the Lone Star and Half and Half varieties.

Thirty-four strains of the Lone Star x Half and Half cross were selected from the 1935 F_5 inbred progeny rows for planting in a field-yield strain test along with the parents of these strains for a comparative study of their values. This planting was made in six replications with each strain or variety being randomized throughout the planting. Results from this test show that each of the thirty-four strains produced higher yields of lint cotton, and thirty-three of the strains had a higher per cent of lint than Lone Star, one of the parents of this cross. Thirty-two of the strains produced a higher yield of lint, and one strain equaled the yield produced by Half and Half, the second parent of this cross. The per cent of lint cotton from the parent Half and Half was greater than the per cent from each of thirty-three inbred strains.

An additional planting was made this season of nineteen selected inbred strains for an increase and field yield strain test. These strains were selected from the 1935 test and planted in four replications with commercial seed of their parents, Lone Star and Half and Half. Results obtained from this test show five strains to have produced higher yields of lint, and nineteen strains to have a higher per cent of lint, than the Lone Star variety. The Half and Half variety produced higher yields of lint cotton than each of the nineteen inbred strains, and had a higher per cent of lint than did eighteen inbred strains.

Corn Varieties

Further studies were made during the year on a comparison of fifteen sweet corn varieties. Poor germination and an insufficient soil moisture supply at silking time resulted in very low yields of edible corn. Highest yields of roasting ears were obtained from Honey June, Hopeland, Surcropper Sugar, Redleaved Mosshart Sugar, and Georgia 439 in the order named. The varieties Honey June, Surcropper Sugar, and Redleaved Mosshart Sugar were outstanding in the low per cent of damage by corn ear worms.

Corn Inheritance and Improvement Test

The work at this station pertaining to the improvement of corn for this section continues the work with the inbred strains of Surcropper and Nacogdoches varieties selected at this station, with the addition of selected inbred strains from other Stations; it also includes the development of a yellow prolific corn for East Texas.

In order to obtain a supply of seed for a field yield strain test of a number of inbred selections, nine Surcropper, nine Blue Grain, seventeen Nacogdoches, and twenty-five Mosshart inbred selections were top-crossed with Texas Golden Prolific during 1936. An analysis of the notes recorded on the seed ears shows two of the strains to be excellent, eleven very good, sixteen good, twenty-four fair, and six to be poor.

During 1936 a field yield strain test of thirty-six inbred strains which were top-crossed with Texas Golden Prolific during 1935, and four commercial varieties, was planted in four replications. A study of the average yields of shelled corn per acre from this test shows that the Surcropper variety grown from commercial seed was surpassed in yield by one hybrid, while twenty-four hybrids produced higher yields than Ferguson's Yellow Dent, twenty-six hybrids were more productive than Mexican June, and Hasting's Prolific was lowest in yield of all plantings made.

In connection with the development of a yellow prolific corn for East Texas, a planting of seed selected from the 1935 planting was made at Weslaco and Nacogdoches during 1936. The Weslaco planting supplied several hundred selfed ears which were selected for deep color of kernel and trueness to the prolific type. The selected ears were planted during June at this station and fourteen pounds of seed, pure for the yellow factor, is available for increase during the 1937 season. Selfed ears obtained from the early Nacogdoches plantings were culled to 62 ears of the desirable type and color and reserved for planting during the following year in an ear-to-row field yield strain test.

Winter and Summer Legume Forage Studies

Studies were made during 1936 on the production of forage of twenty summer legumes. Highest yields of dry forage per acre were obtained from Guar, *Crotalaria spectabilis*, Calico Cowpea, Mammoth Yellow soybean, Chinese Red Cowpea, and Whippoorwill cowpea in the order named. Of five cowpea varieties tested, highest yields were produced by Calico, Chinese Red, and Whippoorwill. Mammoth Yellow, Biloxi, and O-Too-Tan were the highest producing varieties of five soybeans tested. The soybean variety, Mammoth Brown, lost 90 to 100 per cent of its stand from the diseases *Fusarium* wilt and Southern Blight. Two varieties of Velvet beans, Early Speckle and Bunch, did not produce yields in line with results of previous years. Korean lespedeza was the most outstanding of the five varieties of lespedeza tested, followed by Kobe, *Sericea*, and Japan. *Crotalaria spectabilis* continues to be the highest producer of forage of the *crotalaria*s studied. A summary of six years' work shows that the greatest production of dry forage per acre might be expected from *crotalaria spectabilis*, Osceola Velvet bean, Brabham cowpea, Early Speckle Velvet bean, and O-Too-Tan soybean, in that order. During this period Korean lespedeza has produced the highest yields of the five varieties of lespedeza grown. *Lespedeza sericea* is disappointing, due to poor stands secured under East Texas conditions and the spindly type of plant growth, both under cultivated and permanent pasture conditions. For permanent pastures, Kobe, Japan, and Tennessee 76 are to be recommended on account of their ability to continue growth under grazing conditions during the dry summer months.

Tests were made during the year on the forage production of nineteen varieties of winter-growing legumes, and three varieties of winter grasses. Italian Rye grass produced the greatest amount of dry forage per acre, followed by Purple vetch, Hairy vetch, Subterranean clover, and Austrian winter peas. During a five-year period Hairy vetch has proved to be the only reliable winter legume for forage or green manure, as it was outstanding in the yield of dry forage per acre and in resistance to low temperatures. Of the clovers tested, Ladino, Red, White Dutch, Black Medic, and Annual yellow sweet, have made the largest yields of forage per acre. The alfalfas have not proved successful in East Texas because of the high degree of acidity of the soil. Tangier peas have proved to be the best variety of winter peas, although during their blooming period they are somewhat damaged by attacks of the blister-beetle. Of the vetches, Hairy, Purple, and Common are the most dependable from one season to the next.

A general conclusion of the five-years' test on winter legumes is that Hairy vetch can be successfully grown each season for the purpose of protecting the soil and for plowing under as a green manure crop. None of the clovers studied to date produces sufficiently high yields to be grown as an annual crop for green manure purposes, but they do have an important place in the permanent pasture as their yields are

steadily increased once they become established and the correct pasture management is carried out.

Inoculation Studies of Legumes

In cooperation with the Nitragin Company, Milwaukee, Wisconsin, an application of the "Nitragin Culture" was made to twenty-one varieties of summer legumes. In comparing the yields obtained from a two-year study of inoculated plantings and non-inoculated plantings, increases of yields of forage per acre ranging from 8 to 61 per cent on the inoculated plantings of six different varieties of cowpeas were found. Yields from inoculated plantings of four varieties of soybeans ranged from 18 per cent below those of the non-inoculated planting to a 24 per cent increase over the untreated planting. Velvet beans failed to respond to the inoculum as yields from three varieties tested were below those obtained from the non-inoculated plantings. Lespedezas are quite variable in their response to the inoculation treatment as some varieties produced a rather large increase while others failed to approach the yields of the untreated plantings. Guar shows itself to be readily adapted to inoculation treatments, as an increase of 37 per cent in yield was obtained.

Results obtained from inoculation studies on nineteen varieties of winter-growing legumes planted during the winter of 1935-1936 shows Purple and Oregon vetch responding to the treatment while Hairy vetch did not appear to require inoculation. Alfalfas failed to respond to the inoculation treatment, while Austrian winter and Canada Field peas had decided increases from the use of the culture. Six varieties of clovers showed appreciable gains of forage when inoculated while five varieties failed to show any response.

Horticultural Crop Investigations—Blackberry Standardization and Utilization

A large number of varieties of blackberries and dewberries being studied at this Station with the purpose of establishing definite varietal types, of ascertaining the varieties adapted to East Texas conditions, and of selecting varieties for a comprehensive breeding program. The study has shown that a variety may have several names, since it is frequently re-named after introduction to another locality. Results obtained show that high yields are to be expected from the following varieties: Blackberry-Dewberry hybrid, Special, Austin's Improved, Hall's Lawton, McDonald, Texas Wonder, Crandall's Early, Dallas, Young dewberry, Early Harvest, and Rathbun. Early Harvest and Rathbun are varieties having small fruit, while Young dewberry, Hall's Lawton, Alfred, Blowers, Crandall's Early, Lucretia, and Dallas are large-fruited varieties. The earliness of maturity of the Young and Austin dewberries, and of the McDonald and Haupt blackberries, is one of the desir-

able characters of these varieties. The outstanding flavor of the Young dewberry makes it a highly desired variety for any type of production. This desired flavor is also retained when the fruit is canned in either tins or glass, and the pack as a whole retains its shape over a reasonable length of time, although overripe fruits tend to mush. The Alfred, Blowers, Crandall's Early, and Dallas are varieties that show considerable promise but are late maturing. For this reason their yields are greatly reduced by the heat and scarcity of soil moistures at the peak of their maturity. Late maturing varieties have proved to be very susceptible to attacks of Orange Rust and Nematodes. New varieties recently placed in the test have failed to show any decided advantage in yields. The Brainerd is a vigorous variety but matures a light crop of fruit in this section. The Boysen berry has many plant characters of the Young dewberry, with fruit being somewhat larger and quality comparable to that of the Young dewberry.

Blackberry Breeding

Blackberry breeding at this station is being conducted along two lines to introduce high yielding varieties and strains that are superior in flavor and quality to the existing adapted varieties. At the same time an effort is being made to establish certain desirable vegetative characteristics.

First, a large number of selected varieties have been inbred in order to isolate the factors desired for further crossing. Second, a large number of crosses have been made, with the Young Dewberry and Crandall's Early and Hall's Lawton blackberries as pollen parents. These varieties were crossed with a number of other varieties having desired characters and also crossed with each other. During the year 670 seedlings from these crosses were grown under lathhouse conditions and later transplanted to the field.

Observations during 1936 of some 2400 seedlings secured from open-pollinated seed from the McDonald variety showed the procumbent plant character to be dominant as no individual was found to have an erect growth. No one individual plant was found to have fruit of superior quality to those of the female parent. A number of promising seedlings were selected for selling during the coming season in an attempt to bring out a number of desirable characters.

Of 149 seedlings from F_1 crosses and selfs studied this season, 22 showed excellent promise in their resistance to disease, vigor of cane growth, yield, and size of fruit. Further back-crosses and selfs will be made with these selected individuals.

Blackberry Fertilizer Test

During the year twenty treatments in triplicate were again made on a plantation of the Lawton blackberry for the purpose of studying the

effects that fertilizers of different analysis and applied at varying rates had on the yield of fruit, number of new canes, and other factors influencing the production of blackberries under East Texas conditions.

Results obtained from this test during a 5-year period show that the use of varying ratios and amounts does not produce a significant difference in the diameter of the main stem, or of the first, second, or third primary laterals of the blackberry plant. Nor is there a significant difference in the number of clusters of fruit per cane, in fruit per cluster, or in size of fruit. Although there is a slight variation in the number and length of laterals per cane, there is no consistency as the ratios or amounts of fertilizer applied vary. There is a considerable variation in the yield of fruit per acre from the results of various applications of commercial fertilizer. But these differences are not consistent when any one plant food is omitted or increased. The varying amounts of a complete fertilizer do not show a consistent increase when applied at rates varying from 200 to 1000 pounds per acre. Highest yields of fruit per acre were obtained from the application of 800 pounds of a 4-8-4 fertilizer. A continued increase of plants that bear only partially developed fruits is affecting the stand of normal plants, and the yields of marketable fruit are materially reduced.

Blackberry Thinning Test

Five years of studying the effect of five different rates of thinning the new canes of the blackberry shows that when the canes are spaced two feet apart a greater increase of diameter of main stem, and of first, second, and third primary laterals, is obtained. This same treatment shows an increase also in the number and length of laterals per plant. Highest yields of marketable fruit are produced by the thickest thinning rate, the spacing of the plants approximately nine inches apart in a two-foot hedge row. The practice of leaving a full stand of plants in a hedge row two feet wide produced the next highest yields of marketable fruit.

Blackberry Pruning Test

Yields obtained from five methods of pruning blackberries during a 5-year test show that the practice of removing the old canes after harvest without pruning the new canes produced the highest yields. The practice of removing the old canes after harvest and cutting the new canes back to four feet as they reach that height produced the second highest yield of marketable fruit. The practice of mowing all canes off after harvest of the crop resulted in a very poor stand of small fruiting canes for the next season's crop.

Tomato Disease Studies

Continued studies were made at College Station, Jacksonville, and Nacogdoches during the year on a number of plant diseases affecting the tomato in East Texas. The report of the work at College Station will be shown under the report of the Division of Plant Pathology and Physiology. The report of the work at the Tomato Disease Laboratory at Jacksonville is included in the report of this station.

Selection of Tomato Strains Resistant to Fusarium wilt and Southern Blight

During the year two additional treatments of Fusarium wilt inoculum were given the area selected for this work. The first planting of tomato seed selected from the 1935 crop was destroyed by ants in the hot bed. From the second planting some nine thousand plants were obtained for further testing. Due to the heavy infestation of Southern Blight in this area no seed were obtained as the loss from Southern Blight predominated that of the Fusarium wilt.

Adaptability Investigations with Fruit Crops

During 1933 Project No. 216, "Adaptability Investigations with Fruit Crops," was revised with the Texas Extension Service cooperating. At this station a site was selected and terraces were constructed. The trees were spaced twenty feet apart on the terrace, and the terraces were spaced twenty feet apart. The planting to date includes 3 trees each of 45 standard varieties of peaches, 6 lots of selected peach seedlings, 7 lots of selected seedling plums, 6 standard varieties of plums, and 6 standard varieties of pears. During the fall of 1936 a thermograph was set up in the orchard in order to obtain a record of the number of hours the fruit buds were exposed to temperatures of 45 degrees or less, in line with the study to determine the amount of cold required for normal flowering. A total of 537 of the 800 hours required for normal blooming accumulated during the period of October 27 to January 1.

Ornamental Adaptation Study

Continued studies were made during the year on the adaptation of native and foreign plants as ornamentals for the improvement of the home and its surroundings. Two specimens which are outstanding at the present are Camellia Sasanqua, an evergreen that blooms during November and December, having flowers of medium size, petals white, anthers large and yellow, and Camellia Japonica, also an evergreen, having medium to large red flowers appearing during the months of February

to April. Both specimens have been exposed to 8 degrees with no resulting damage. Pineapple Guava, Feijoa Sellowiana, certainly deserves a place in the foundation planting of a building with its variable foliage of gray on the underside and green on the upper surface, flowers large, white petals with brilliant coloring of red in center. All varieties of Pyracanthas tested show they have the factor of adapting themselves to a wide range of light conditions and can stand any rate of pruning.

The bush-type honeysuckle, *Louicera implexa*, with its many bright red flowers and attractive foliage, is pleasing in a bed of flowering perennials.

Reforestation

Continued work was done during the year on plantings of black walnut, black locust, Tung oils, Asiatic chestnuts, and Splash pine, in the use of submarginal lands of East Texas by reforesting in connection with the development of permanent pastures. Yields of nuts obtained from individual Tung oil trees show a wide range of difference in the ability of the individual trees to withstand severe cold injury during the winter, and hardness of the fruit bred to cold injury of frosts in the late spring. Growth records on Slash pines show them to have made an average tree growth of 8.2 feet during the first five years after being planted on the Nacogdoches soil type. Some of the taller trees are 11 to 12 feet in height.

H. F. Morris.

East Texas Pasture Investigations Laboratory, Lufkin

The East Texas Pasture Investigations Laboratory is located six miles west of Lufkin, Angelina County, Texas, on 235 acres of land adjoining State Highway No. 94. The elevation ranges from 217 to 270 feet from the southeast to northwest corners, respectively, and this gradual slope is broken only by several crooked gullies and sand mounds. The water table on the average is very near the surface. Water supplies of sufficient strength for wells are found only in veins at depths of eighty to one hundred feet.

The average annual rainfall at Lufkin over a period of more than twenty years is 44.48 inches, and the month of greatest rainfall is May, followed by December. The prevailing topsoil is a fine grey sand ranging from a few inches to several feet in depth. It is medium acid in reaction and very low in organic matter. The subsoil is usually an impervious clay. The average length of the growing season is between 250 and 260 days. In its present native state the soil is covered mostly with new growth loblolly and short leaf pine, various hardwoods, and underbrush. This growth of timber is usually so dense that very little grass can grow. In the area around the trees where the grasses should

grow, only a mass of pine straw and leaves is to be found. In the more open places, or where the timber is more mature, thus admitting sunlight more often, native grasses are growing. Of the native grasses sage predominates. Since the acreage of actual grass is such a small per cent of the total, the carrying-capacity of the land is quite misleading when figured on the basis of total acreage.

The above description of the station land is typical of many thousands of acres of new growth and young timber land in the East Texas Forest Region.

Mineral Deficiency Studies: Twenty-five two-year-old Hereford heifers were used to study possible deficiencies of iron, cobalt, copper, and phosphorus. Copper, when supplied in doses at the rate of two milligrams to one hundred pounds live weight per head per day, has given the greatest increase in gain for a period of 308 days. The lot of heifers that was used as a check received nothing in the form of a mineral except salt as a lick. At the end of the 308-day period the five heifers receiving copper daily in a drench averaged 72.3 pounds heavier than those heifers in the check lot. After 252 days they had grown 1.6 centimeters in length, 1.4 centimeters in width, .8 centimeters in height, and 1.4 centimeters in circumference of left front cannon. The other minerals produced slight gains over the check lot.

Adaptability of Herefords to East Texas Conditions: This was the second year that the station herd of twenty-seven heifers and a bull has been studied from the standpoint of adaptability. The heifers went into the spring averaging 630.5 pounds and by fall they were averaging 913 pounds. They were fed in dry lot during January and February, and were then turned on the improved pastures where they stayed until a short time after killing frosts in November. At that time, because of grass shortage in the improved pastures, they were placed in the station "woods" pasture. Due to the fact that these heifers were on an experiment that required excessive daily handling, they were fed a small amount of cottonseed cake from March until July. Only two dippings to rid them of ticks were necessary during the year. They were doped twice for ear ticks. Otherwise no damage or symptom from parasites or diseases was noted. Although a few of the heifers have never been thrifty, as evidenced by their failure to shed their winter coat of hair completely, the herd as a whole was thrifty and some of the heifers went into the winter fat. At present these cattle seem to be about as large and as fully developed as average range cattle of the same age—coming three-year-olds. According to the indications of the results obtained this year, Herefords may be successfully handled on an intensive scale in East Texas. However, it is still doubtful whether or not they would be successful if handled in the same manner as native-range cattle.

The behavior of these cattle for the first year under East Texas conditions is given in the forty-eighth annual report.

Permanent Pasture Studies: These studies have been conducted on 42 acres of typical old-field bottom land. The 1935 fall planting of Italian Rye grass furnished grazing two or three weeks before the summer grasses and legumes were available. A 1934 planting of Louisiana White and Hop clover on a part of the pasture furnished the majority of late winter and early spring grazing. In fact these clovers showed so much promise of furnishing the greatly needed winter pasture that a blanket planting was made of them in the fall.

As a whole the rainfall for the year was below the average, thus making for better pastures, based upon the assumption that above the average rainfall, such as that encountered in 1935, is only detrimental to East Texas pastures. During the summer and fall Carpet grass, Common lespedeza, Bermuda, and Dallis grass furnished the majority of the heavy grazing for the period. For 260 days, from March until December, this pasture was the main factor in producing a gain of 8146 pounds on twenty-eight head of cattle. The carrying-capacity amounted to 1.5 acres per cow for the 260 days. Over 150 grass samples taken for yield and chemical analysis show that this pasture produced daily 119 pounds of green edible forage per acre throughout the summer and fall. Chemical analyses of these samples have not been made, but analyses made this year of samples taken in 1935 show that the protein and mineral content of the pasture is only slightly below that of grasses from the western ranges. However it is imperative for Lespedeza to be in the pasture mixture in order for the protein and mineral content to be that high. Work toward improving the permanent pasture this year consisted mainly of management problems, since the problem of sodding it to the desired grasses and legumes had almost been solved the year previous. Three mowings were necessary to keep the forage uniform in height, short, more nutritious, and growing. Work was begun toward taking nearly all of the shade trees out of the pasture. An application of triple super-phosphate at the rate of 300 pounds per acre was made in September. After failing once, Rescue grass was given another trial, being planted at the same time that Louisiana White and Hop clovers were planted. A better stand of the grass was obtained this time.

The encouraging factor in regard to permanent pasture improvement in East Texas is that, based upon our results so far, old-field bottom land can be developed within two or three growing seasons into pastures that will not only maintain but fatten cattle at the rate of 1.5 acres per cow.

Introduction of New Forage Plants: During the year the introduction garden, where the plants are grown for first observations, was rearranged, providing 10' x 10' beds, drainage for each bed, walks, roadways, and areas for making increased growths. All perennials were transplanted onto the new beds and all annuals replanted. Several more grasses and legumes were added to the collection through the year.

There are now approximately 120 plantings in the garden of various grasses and legumes. To date none of the plantings shows exceptional promise; however increase plantings were made of several of the promising grasses in order to observe them under actual grazing conditions. *Cynodon barberri* and *Cynodon plectoistachyum* appear to be the most palatable and aggressive of those studied. The grasses for this grazing test were protected from livestock and native vegetation until they obtained a good start. Some twenty grasses and legumes planted or transplanted on native pasture sod, without protection, either died or made very poor growth in competition with the native grasses.

Effect of Fertilizers on Forage Plants: Only one fertilizer study was begun before fall; therefore few records on yield could be obtained before frosts. From observations, a quick response of short duration was obtained from nitrogen but the forage did not evidence any response to phosphorus.

Combination Timber and Pasture Production Investigations: It was reported in 1935 that fair grazing could be expected where pine trees (of average size) are in stands of 200 or less per acre. Observations this year indicate that the stand of timber should be less than 150 trees per acre for grass to grow in sufficient amounts. In this test there are four thinned areas ranging in degree of thinning from 175 to 350 trees per acre. Areas number one and three are thinned to 175 and 275 trees per acre, respectively. Area number one yielded 1.2 tons of air dry forage per acre from June 10 to November 14, and area number three produced .75 tons of air dry forage during the same period. All this forage is native, having come in of its own accord. The reaction of the trees to the different degrees of thinning will not be known until 1939 when measurements, similar to those taken at the beginning (1934), will be made.

Temporary Pasture Studies: In order to try to find some means of wintering cattle without supplementary feed, an old upland field was prepared, fertilized, and planted with oats, Italian Rye grass, and Hairy vetch. Normal germination was obtained from all the seed, but growth was slow. The pasture has not furnished enough grazing yet to offset feeding. The winter pasture is to be followed next summer by Sudan grass for emergency grazing and hay.

Sugar Cane Test: The variety test was continued in the same manner as reported previously. However it was enlarged to include three more varieties new to the area. They are Co. 29-320, Co. 28-11, and Co. 28-19. In this area of East Texas, sugar cane is grown entirely for sirup and the crop ranks high as a cash crop in several counties. Native, or Louisiana Purple, is the most common variety grown and it has been used for many years. For several years its yield has been materially decreased because of a Mosaic disease. The purpose of these variety studies is to bring to this region those varieties known to be tolerant

or immune to the disease in Louisiana and test them under our conditions. Nine varieties have been grown and compared with the Native. For the third consecutive year, the Native made either the lowest or next to the lowest in yield of sirup per acre. This year it was next to last with 168 gallons of sirup per acre, and one of the newest varieties Co. 28-11 was last with 164 gallons. Varieties C.P. 807 and Co. 290 give consistently the highest yields. Their yield this year almost doubled that of the Native sugar cane. Only one variety, P.O.J. 36M, produced a higher yield than the C.P. 807 and Co. 290 varieties this year. All three of these varieties make sirup of as good quality and taste as the Native or Louisiana Purple and at the same time produce almost two gallons of sirup for every gallon produced by the Native.

In the sugar cane fertilizer study, a high yielding variety, C.P. 807 was used, and six different fertilizers were applied as a side dressing when the cane was about two months old. The results indicate that it is not profitable to fertilize sugar cane on bottom land that is relatively new. However, since 1936 was not a good year for testing fertilizer in this region, it is planned to repeat this test. The greatest increase in yield was obtained from an application of 500 pounds of 8-8-4, of which one-half nitrogen was in cottonseed meal and one-half in nitrate of soda. This increased yield, however, amounted to only sixteen gallons of sirup.

Rural Telephone Pole Experiment

This experiment was ended during the year when it became necessary to move the line in order to clear the right-of-way for a rural electric line. Since it had been in existence only two or three years, very little difference in deterioration could be noted in the four kinds of timber and the eighteen treatments used.

E. K. Crouch.

TOMATO DISEASE LABORATORY, JACKSONVILLE

Effect of certain sprays or dusts on the foliage or fruit of tomatoes:

More than 100 different sprays or dusts were tested on tomato leaves and fruit to determine whether any of these would cause slight or serious burn. On the basis of the tests, the following are regarded as safe: Dust No. 49 consisting of 85 per cent 300-mesh Spider brand sulphur, 5 per cent Cuprocide, and 10 per cent calcium arsenate. The following sprays were found safe for tomato foliage: Spray No. 21 consisting of 8 pounds Bordeaux powder, 5 pounds Mist brand sulphur, and 1½ pounds calcium arsenate, and 50 gallons of water; Spray No. 24 consisting of ¾ pound copper KB, 5 pounds Mist brand sulphur, 1½ pounds calcium arsenate, and 50 gallons of water; Spray No. 78 consisting of 1 pound Cuprocide, 5 pounds Mist brand sulphur, 1½

pounds calcium arsenate, and 50 gallons of water. A straight spray of Cuprocide practically controlled Septoria leaf spot in the Glovel tomato.

Susceptibility of tomato varieties to *Fusarium lycopersici*: In one field at Jacksonville, 99 per cent of the Gulf State Market tomato plants died from Fusarium wilt, reducing the yield to 53 bushels of tomatoes per acre, whereas ordinary average good yields are from 250 to 600 bushels per acre. The Glovel and Scarlet Dawn varieties, considered by some to be resistant to Fusarium wilt, proved to be highly susceptible to *Fusarium lycopersici* under conditions of Jacksonville, Texas. The Marglobe variety showed enough resistance to yield a profitable crop of fruit before they had completely died from Fusarium wilt.

Attempts to secure wilt resistant varieties of tomatoes: Tomato seed were saved from Gulf State Market and Marglobe plants which grew in an extremely infested field and did not die from Fusarium wilt. The seeds from these selections will be planted during 1937 on heavily infested land and this will be continued for several years until a strain of tomatoes is obtained which may grow in spite of the disease.

Chemical seed treatments to control damping-off of tomato seedlings: Tomato seeds were treated with Cuprocide, "AAZ" Special zinc oxide, Vasco 4, and copper KB, all of which gave good results in controlling pre-emergence damping-off. Each of these chemicals was used at the rate of 713 milligrams per ounce of seed or 2.5 per cent. Even when used at the possible maximum rate, no injury was noted from any of these 4 chemicals to either seeds or seedlings. Ceresan and Semesan Jr. were also effective when used at the rate of 2.5 per cent of the chemical but injured tomato seed when used at higher rates. Copper sulphate (1 per cent solution) and Semesan (0.25 per cent solution) were used in wet treatments of tomato seed and gave satisfactory control of pre-emergence damping-off of tomato seedlings.

Effect of light in controlling damping-off of tomato seedlings: Experiments indicated that much bright light, preferably 400 to 650 foot candles, aided the growth of tomato seedlings to such an extent that they were able to escape infection from damping-off. Best results were obtained from direct sunlight.

Chemical soil treatments to control damping-off of tomato seedlings: Cuprocide treatment of the soil immediately after planting the seed, applied at the rate of 1 ounce of the Cuprocide suspended in 3 gallons of water and sprinkled over 20 square feet of soil, helped greatly in decreasing post-emergence damping-off of tomato seedlings. Zinc oxide dusted on the soil showed little beneficial effect in controlling post-emergence damping-off.

Chemical soil treatments to control nematode: Chloropicrin and carbon bisulphide were injected into nematode infested soil by using a sharp

tube-peg board that was made for this purpose. The heavy applications of carbon bisulphide gave good control of nematodes as tested by growing watermelon plants in the soil. The watermelon plants were used also in the other plats to test nematode infestation in the soil. In one series, chloropicrin gave near control of nematodes in one plat, but only fair control in two other plats. In another series chloropicrin gave excellent control of nematodes when used at the rate of 300 to 450 pounds per acre but gave only fair control when used at the rate of 150 pounds per acre.

Miscellaneous Diseases

Plant disease survey: A survey was made of tomato diseases in East Texas and the following were found destructive in that region: Fusarium wilt, Southern blight, nematode root knot, early blight, Septoria blight, bacterial spot, mosaic, puffing, and blossom-end rot. The following diseases have not as yet been reported from Texas: oak, *Quercus marilandica*, affected by a leaf spot, *Hypoderma ilicinum*; a rust of long leaf pine, *Pinus palustris*, caused by *Peridermium carneum*.

Irish Potatoes

A drouth-resistant Irish potato: Potato selection No. 569 of the Bliss Triumph variety previously developed by Young was tested at Jacksonville and showed considerably more drouth resistance than did the Sharples selection of Bliss Triumph potato. Previous work by Young has shown that selection No. 569 was resistant to frost and also strongly resistant to *Alternaria* blight.

Watermelon

Testing resistance of Iowa wilt-resistant watermelon varieties: Improved Kleckley Sweet and Improved Stone Mountain watermelons were obtained from the Iowa Experiment Station through Dr. Taubenhause. Both of these varieties showed high susceptibility to Fusarium wilt, *Fusarium nivum*, when grown at Jacksonville, Texas.

P. A. Young.

SUBSTATION NO. 12, CHILLICOTHE

(In Cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

Substation No. 12 is located four and one-half miles south and one mile west of Chillicothe, Hardeman county; longitude 99 degrees west, latitude 34 degrees north, and elevation 1406 feet above sea level. The Station, which comprises an area of 100 acres of land, serves a region

in the northern part of the Rolling Plains area in which the Vernon, Foard, and Abilene soils predominate.

This Station was established in 1905 as a forage crop-testing station operated by the U. S. Department of Agriculture and the Texas Agricultural Experiment Station. The cooperation has been continued to the present. During the early years an important phase of the work consisted of testing crops recently introduced from foreign countries and resulted in the introduction and distribution of Sudan grass and the now important varieties of grain sorghums, feterita and Hegari.

In common with all others, this Station is collecting reliable information on the proper procedure in crop production and soil management. Varietal and cultural experiments are being made with all of the important crops. All new species, including grasses and legumes, that might prove valuable are tested as they are introduced or become important. Some attention is being devoted to vegetables and fruits for production in home gardens and orchards, and to ornamental plantings of trees and shrubs. The unique feature of the work at this Station is the investigations under way with sorghums. The most complete nursery of both forage and grain types of sorghums in the United States is maintained at this point. An intensive study of inheritance of sorghum is under way and the production of new and superior varieties is the aim of an inclusive plant breeding program.

Cotton Experiments

Cotton Variety Test: Production this season was the lowest on record. There was considerable variation in yield with well-adapted varieties producing approximately twice as much as unadapted ones. Under such adverse growing conditions Half and Half did not show its superiority as it does in a favorable season, this variety producing about 10 per cent less than the Chillicothe selected strains of Mebane. The highest producing variety was Hi-Bred, a new strain being sold by B. F. Summerour of Norcross, Georgia. In this test, under the adverse conditions that existed, this new variety had the same lint length as Half and Half, $3/4$ inch. The yield of Hi-Bred was 116 pounds of lint to the acre. The two Mebane strains 140 and 141, selected at and distributed from this Station, produced cotton of tenderable length and the acre productions were 115 and 112 pounds. Western Wonder was fourth in production with 107 pounds to the acre. The production of Acala was 88 pounds to the acre and of New Boykin and Ferguson 406, 85 and 84 pounds, respectively. All of the Mebane strains adapted to Central and South Texas, including Mebane, Qualla, Cliett, Harper, and Kasch, produced 80 pounds to the acre or less. The new variety Paymaster is apparently a selection from Acala and there was practically no difference between the two in appearance or behavior in this test.

Date of Planting: There was no effective rainfall from June 12 to September 4 and during August the most serious drought of recent years occurred. Also there was a very heavy infestation of the cotton flea hopper that resulted in greatest loss in the June planting of cotton. On account of the drought and this infestation yields were greatest in the April and least in the June planting. The actual lint yields to the acre from the three plantings were as follows: April, 113 pounds; May, 72 pounds; June, 33 pounds.

Fertilizers for Cotton: The fertilizer test is located on soil that has been in cultivation for almost fifty years and cotton has been planted on this land continuously for the past ten. The application of commercial fertilizer and of manure to identical areas during the past nine years has not resulted as yet in increases in production. In a very dry season, such as that just past, certainly soil moisture and not plant food is the limiting factor in production.

Cotton Breeding: That phase of the cotton breeding program begun in 1925, which had for its aim the isolation of a high-producing variety of tenderable staple length for this territory of Northwest Texas, was completed with the distribution of two strains, Nos. 140 and 141. The former strain, which is particularly suited to "snapping," has been adopted by a well established commercial seed company and the latter strain has been adopted by two commercial seed firms. This Station will continue to maintain pure stocks of these two strains.

The new program of cotton improvement at this Station has for its aim the development of varieties adapted to this territory that will produce fiber of unusual strength. Primarily the program consists of incorporating the inherited characteristic of strong lint into the genetic make up of the variety now most widely grown. This program is made possible by the fact that an unusually strong fibered strain was isolated from Mebane during the progress of the previous breeding program. In 1936 a number of plant selections were found that had fiber one-half again as strong, as determined by laboratory breaking tests, as any commercial variety grown under similar conditions.

Experiments With Corn

All varieties in the variety test failed completely on account of the very serious drought.

An increase block of Golden June corn on more sandy soil produced a small amount of grain, and slightly less than 50 bushels of this new and valuable variety will be distributed in the spring of 1937.

Experiments With Sorghums

The yields in 1936 were the poorest since 1918. Serious droughts have occurred in other years but this season was the only one in recent

years in which sorghums that were alive when the drought was broken did not recover and produce grain. Fifteen inches of rain fell in September, and as the weather during October was not favorable to plant growth no varieties matured grain from the new growth following the rains of September.

In the variety test largest yields were produced from April planting. A comparison of the yields of the different varieties is hardly justified as all the yields were poor.

Sorghum Breeding: Approximately 200 progeny rows of Dwarf Yellow milo resistant to Milo Blight, *Pythium arrhenomanes*, were grown for the purpose of picking out the best strain for distribution. Seed of this resistant strain will be distributed in the spring of 1937.

Favorable reports of the new variety Quadroon were received from all of the sorghum growing regions of the State except the Gulf Coast and this new variety, which is three-quarters milo and one-quarter kafir, promises to be an important addition to our list of adapted grain sorghum varieties. Quadroon is a dwarf, early, straight-headed, yellow-seeded variety that will produce consistently under very adverse conditions. The variety resembles Dwarf Yellow milo in many respects.

The unfavorable season did not greatly hinder the program of sorghum improvement that has for its aim the creation of yellow-seeded varieties of feterita, kafir, and Hegari; a sorgho variety with palatable grain and resistant to foliage diseases; and strains of Sudan that are sweet and juicy, and whose seed can be distinguished from Johnson grass. The breeding work has progressed far enough along these lines to make it appear certain that all of these objectives will be reached.

Inheritance Studies: Seed stocks of some sixty pairs of contrasting characters have been obtained and the lines are being intercrossed as rapidly as they can be studied in the segregating generations. Many of these characters are seedling and mature plant chlorophyll abnormalities that have been isolated following natural occurrence in greenhouse, or field plantings during past years; and several were produced by irradiation of sorghum seed.

Among the recent additions to these characters is a male-sterile observed in Texas Blackhul kafir in 1935. The single plant found was used as the female parent in several crosses and a few of the crossed seed were grown in the greenhouse at the Main Station during the following winter, making possible F_2 populations at Chillicothe this year. These populations segregated into a ratio of approximately three normal to one male-sterile plant, although there was a deficiency in the recessive classes of some populations. The anthers of male-sterile plants fail to produce pollen and are less than half the size of normal anthers. The flowers bloom in a normal manner. This character has possibilities

for the development of a practicable method of producing crossed seed in quantities sufficient for field plantings.

Leoti sargo is one of several varieties which appears to have some resistance to one or more of the foliage diseases common to sorghum. The glumes of this variety are sienna-colored and spots on leaves and stalks from insect injury or disease are not as intensely colored and are much less conspicuous than spots on most varieties. In 1934 it was observed in crosses of Leoti and black-glumed varieties that the F_2 populations segregated in ratios of approximately nine black-glumed, three mahogany-glumed, three red-glumed, and one sienna-glumed plant. Both the mahogany and sienna-glumed plants had the foliage appearance typical of Leoti, while the black- and red-glumed plants had the more conspicuous black or red discoloration. In the same year F_2 populations of red-glumed varieties x Leoti segregated into classes of three red-glumed to one sienna. In 1935 the F_3 populations behaved as expected: black phenotypes bred true or segregated; mahogany bred true or segregated three mahogany to one sienna; red phenotypes bred true or segregated three red to one sienna; and sienna phenotypes bred true. These results indicated that these types of mahogany and sienna are caused by a recessive modifying gene which affects plant color, mahogany being modified black and sienna modified red. Tabulation of phenotypes in the F_2 and F_3 generations clearly showed association of this plant color modifying gene with the factor for white-cloudy midrib. The factor for midrib is further associated with seedling stem or coleoptile color. Linkage relations have not been determined exactly because climatic conditions during the past three years have made many of the phenotypic classifications unreliable, but the results show that the gene for seedling stem color is between the other two and is closer to the plant modifier gene than the midrib gene.

Small Grain

Wheat Varieties: The production of grain of the different varieties was close to the period of years average, being between 15 and 20 bushels per acre. This production was considerably above that of this general region and the greater yield is attributed to a local rain in the fall of 1935 that amounted to about 5 inches. Tenmarq was the outstanding variety in point of yield and it is becoming increasingly apparent that this relatively new variety is good enough to be recommended to replace the varieties now in general use, such as Turkey, Kanred, and Clark's Blackhull.

Legumes

Alfalfa is an excellent crop in this area, either for pasture or hay, and the acreage devoted to it should be increased. On account of the severe and protracted drought only four cuttings were obtained this season, the

first of which was in May, the second in June, the third in July, and the fourth in October. The last two cuttings were light, being only about $\frac{1}{2}$ ton per acre each.

The year 1936 was the sixth year of the variety test, and as the figures accumulate, a strain of common alfalfa known as Dakota No. 12 begins to take a commanding lead in production. The Grimm variety appears to have no particular advantage here and the Turkestan strain and Hairy Peruvian are definitely inferior.

During the last three seasons Rescue grass has become a serious pest which reduces the amount of hay produced at the first cutting and also lowers the quality of the hay. This grass will undoubtedly affect the stand of alfalfa adversely.

Sweet clover is another crop that can be of considerable value if properly used. Sweet clover is a very good pasture crop itself and its beneficial effect upon succeeding pasture crops of Sudan grass and wheat is very marked. It is estimated that the carrying capacity of wheat during the fall and early winter is at least half as much again on the pasture following sweet clover as on the pasture with no sweet clover in the rotation.

Miscellaneous Legumes: There are relatively few seasons in which fall planted legumes of such species as White Dutch and Alsike clovers, Crimson clover, the vetches, Canada field peas and Austrian Winter peas will do well and in most years Austrian Winter peas and Hairy Vetch will be the only two that will survive. These two were the best of the winter legumes this year. Austrian Winter peas produced .91 ton of dry hay per acre and Hairy Vetch produced .55 ton. Hubam clover produced 1.07 tons of air-dry forage and second-year sweet clover produced 1.70 tons.

The summer growing legumes were, with a few exceptions, complete failures in 1936. Mung beans made a light crop of seed prior to the severe drought. Guar survived the drought but growth was poor following the fall rains. Other species, including all cowpea and soy bean varieties, died during the summer months without producing seed.

Grasses

A nursery of grasses continues to be grown but no grass worthy of distribution has been found.

Approximately 10 per cent of the Buffalo grass seed planted at the rate of two pounds to the acre in the early fall of 1935 came up following the first rain after planting. The seed had been planted in rows 36 inches apart and the stand averaged about 1 plant every foot. At the end of the growing season of 1936 the grass covered the ground with the exception of a few scattered spots.

Seed planted in October of 1935 germinated about 10 per cent following a rain shortly after planting. These plants were killed by the first freeze and another 10 per cent germination from this same seed occurred in the spring of 1936. At the end of the growing season in 1936 approximately one-half the ground was covered with grass from this emergence.

A third planting of grass, using seed from the same lot used in the two previous plantings, was made in dry soil in March of 1936. Within five days following a rain on April 15 there was emergence from 15 per cent of the burrs. At the end of the growing season there was a solid stand in the drill and there was a strip of uncovered soil only three to six inches wide between the 36-inch rows.

Laboratory germination of the seed planted in these tests was 65 per cent. This seed was harvested in the spring of 1935. The laboratory germination of the seed harvested in the spring of 1936 was 48 per cent.

All of the seed used in these tests was harvested by suction. It is apparent from these studies that a good covering of Buffalo grass can be obtained in a single season provided there is seed in the ground amounting to as much as two pounds to the acre. It is necessary, of course, that conditions be favorable for the survival of the seedlings if these results are to be obtained.

J. R. Quinby and J. C. Stephens, Bur. Pl. Ind.

SUBSTATION NO. 14, SONORA

Substation No. 14 is located in Edwards and Sutton counties and comprises 3461.63 acres. The latitude is 32 degrees north and longitude 100 degrees west; the elevation is approximately 2400 feet above sea-level. The average annual rainfall over a period of 17 years is 25.16 inches. This year shows 2.82 inches more than average. Sixty acres are in cultivation for the growing of feed crops while the balance is used for grazing purposes.

The Station was established for the purpose of serving an extensive area known generally as the Edwards Plateau region, where livestock is the predominating agricultural resource. Sheep, goats, and cattle are the principal livestock of the region. This region produces the great bulk of the sheep produced in Texas, which ranks first of all the states in the number of sheep and the quality of wool produced. The region also produces the great bulk of the Angora goats, producing 86 per cent of the nation's crop of mohair.

Studies in diseases of livestock, particularly the diseases of sheep and goats, constitute part of the Station's activities, inasmuch as these occur under range conditions where, unlike other sections, loose herding is quite generally practiced. Another part is the study of inheritance of

desirable and undesirable characters in sheep and goats. The study of external and internal parasites affecting livestock is also included. Other problems relate to the study of the forms of vegetation that make up the range feed value, the number, diversity, and occurrence of these different species, and the sequence in which they occur and contribute to the total carrying capacity of the range.

Cultivated Crops, Shrubs, Flowers, and Vegetables

Sixty acres of land are in cultivation for the production of feed for livestock. Sorghums constitute the main crop. This year approximately 15,000 bundles were raised and harvested. In addition a trench silo 80 feet long by 7 feet deep by 8 feet wide was dug and filled half full during December this year with feed cut in August. This feed was damaged in the shocks by heavy rains in September, but it is felt it may be of more value for sheep in the form of silage than when fed dry. The silage will be utilized during the lambing and kidding operations or preserved until more adverse range conditions exist. Thirteen tons of milo heads were harvested. Records for feed crops planted here show excellent yields four years out of six.

No experimental work is done with vegetable gardens, but the residences on the Station have been able to produce early spring and fall products of radishes, spinach, onions, beans, beets, carrots, okra, turnips, and potatoes. Tomatoes are invariably killed out by a disease believed to be wilt. These gardens have been produced by surface irrigation in the past, but in one garden tile has been installed for the purpose of supplying subirrigation and determining its advantages over surface irrigation for the production of home vegetable supplies. Results of this system were entirely satisfactory this year; it requires less water and makes possible a more abundant growth of plants.

The most satisfactory flowers grown here seem to be sweet peas, chrysanthemums, zinnias, various bulb plants, morning glory, and castor beans.

The introduced shrubs on the Station, including privet, arborvitae, juniper, cypress, and Nandina, have grown satisfactorily and have greatly improved the landscape. The plantings of yucca, cacti, senecia, and Huajillo, which are native, have been well established in some of the yards. More native shrubs, such as rosin bush and rubber plants, have been planted. Two fig trees irrigated have produced abundant crops of fruit for several years.

Prickly Pear Eradication

During the past few years prickly pear has been encroaching on the sheep and goat ranges of southwest Texas to the extent that it is becoming a menace. The increase on the Ranch Station has been from

16 plants to 31 plants per acre. It has long been known that some cattle would become chronic pear-eaters throughout the year if they were fed on the plant to some extent during the winter, but it has not been a great source of trouble among sheep and goats until the past four or five seasons. Sheep and goats begin on the new spring growth of the plant and continue eating throughout the summer, regardless of the season or condition of other desirable vegetation. The spines on the plants prick their mouths and produce sores which make them readily susceptible to screw worm infestation. These conditions exist on a large number of ranches in the Edwards Plateau region and the owners are eager for information as to how prickly pear problems can be solved.

This Station, in cooperation with the Division of Agricultural Engineering, began in January, 1933, to determine the best method of prickly pear control. Spraying and stabbing the plants with various chemicals and poisons at different times of the year was first outlined. Equipment for the work had to be devised and made. The best poison found (arsenic pentoxide) is obtainable at 25c per pound for the United States product or 8½c for the imported product. A repetition of the poisoning tests that were conducted in 1933, 1934, and 1935, was run in 1936. It was again found that the proper time to kill the plants by poisoning was during the summer months. The most satisfactory poison found thus far is 2½ pounds of arsenic pentoxide dissolved in one gallon of water to which is added ½ pint of commercial sulphuric acid. In 1934 the cost of applying this solution with an Australian atomizer on 781 prickly pear plants, or an average infestation per 25 acres, was 13½c per acre for labor and material. The price of 97 per cent pure arsenic pentoxide in this test was 37 cents per pound. A recent quotation on arsenic pentoxide 84 per cent pure is 8½ cents per pound for an imported product. At the latter price the cost of poison for prickly pear eradication should be within the reach of all interested users.

Livestock have been left in the pastures where the poisoning tests have been conducted. Extreme care has been exercised in keeping the poison off all vegetation except the prickly pear, with the result that we have not experienced trouble from arsenic poisoning in livestock. However, it is not to be recommended that the stock be left in the pastures where poisoning work is going on.

W. H. Dameron, H. P. Smith.

Spineless Cactus (*Opuntia Ellisiana*)

Due to having exhausted our supply of spineless cactus during 1934-1935, no additional feeding tests have been conducted. Also a considerable amount of disease (Sun scald and anthracnose) damaged a seven-acre planting of cactus with the result that it was plowed up. Two attempts have been made to replant this acreage. They have been

unsuccessful in that after the plants or slabs had taken root, disease again appeared, killing 60 per cent of the new plants. The area will be cultivated for about two years before it is planted to cactus again.

W. H. Dameron.

Cedar and Mesquite Eradication

The spread or increase of cedar and mesquite on the range is causing considerable concern to ranchmen by choking out the grass and other desirable vegetation. To gain some information on eradication, spraying tests were run this year. Kerosene sprayed on the trunk and around the base of mesquites in early June killed 60 per cent of the trees. Forty per cent had the tops killed but put out new growth from the base of the trees. Indications are that enough kerosene must be applied to saturate the soil around the base of the trees to get satisfactory results. Neither kerosene nor arsenical poisons have been effective in killing cedar by the spraying method.

W. H. Dameron, H. P. Smith.

Bitterweed Control

Bitterweed germination in the fall of 1936 in this area has been tremendous on all areas not well covered with grass sod. There has also been a heavy germination in the grass sod but these weeds are not making the growth that the weeds are where they do not have competition for soil moisture.

A considerable amount of bitterweed trouble (poisoning) began in December this year in sheep. This condition is attributed to lack of variety of desirable succulent winter forage plants and a considerable amount of accidental eating of bitterweed seedlings that are present in the grass turf. The ranches that are experiencing trouble are having to move their sheep off bitterweed to the feed pens or to territory where there is no bitterweed. This incurs a heavy expense to the stockmen.

Bitterweed has spread extensively during 1935 and 1936 on account of the heavy rains and flood conditions experienced those years. Seeds of the plant were carried down the drainage areas and deposited along the banks of the draws and streams where the plant has not been present before. The seeds thus transported and deposited have germinated with the result that the weed will probably be a menace unless the ranchmen realize the seriousness of the situation and destroy the bitterweed plants as they appear on their premises. Under these conditions it is perhaps best to pull the weeds up when they begin to bloom, and sack and burn them. Follow this procedure several years, if necessary, to prevent the maturity of a seed crop and spread of the weed to the rest of the pastures.

Lighter stocking of the range where bitterweed is a menace, or threatens to become so, offers considerable encouragement in the form of control. In 1931 the Ranch Station reduced its stocking capacity from 64 units per section to 50. At that time three quadrat counts showed a bitterweed infestation of 5,800,000 plants per acre. In 1936 these same quadrats had an average infestation of 500,000 plants per acre or a reduction of little over 91 per cent. Grass cover is increased manyfold.

To gain some information on excluding livestock from definite areas to eradicate or control bitterweed, three small enclosures were made in 1931 in three different pastures and under three different conditions. The bitterweed infestation on these areas averaged 5,155,878 plants per acre. In 1936 these same areas had 60,705 plants per acre or about 99½ per cent decrease. Increased grass and other desirable forage cover is pronounced; in fact, it has replaced bitterweed.

W. H. Dameron, V. L. Cory.

Animal Breeding and Production

Mineral Feeding: The question is frequently asked in this region if there is any benefit to livestock from feeding mineral in the salt lick. In an effort to give accurate information on this subject, this Station has had grasses and forage plants analyzed for feed value and mineral content all months of the year. To supplement this information, in June, 1934 the Hereford cattle comprising 54 head, were divided into two groups, and the grade Rambouillet ewes, comprising 300 head, into two equal groups. One group of each class was placed in one pasture on a 50 per cent bone meal and 50 per cent salt mixture, and the other group was placed on plain salt in an adjoining pasture. Individual weights of the animals were taken at the beginning of the test. An accurate record of the consumption of salt and bone meal was kept for the respective groups. The animals were alternated in the pastures every thirty days, complete production records were kept, and in addition specified individuals of each group of cattle and sheep were used for blood analysis tests in the spring and fall of the year. This year the bone meal-salt group cows raised 18 calves with an average weaning weight of 420.7 pounds, while the plain salt cows raised 17, with an average weaning weight of 388.94 pounds. Out of the bone meal-salt group 115 lambs were marked with an average weaning weight of 59.7 pounds, while the plain salt group 107 lambs were marked with an average weaning weight of 59.4 pounds.

W. H. Dameron, O. L. Carpenter.

The Inheritance of Polled Rambouillets

In the fall of 1935, 59 head of ewes were bred to polled rams at this Station. Forty-six lambs were weaned from the 59 ewes in the fall

of 1936. The results will be found in the report of the Division of Range Animal Husbandry.

B. L. Warwick, W. H. Dameron.

Adaptation of Corriedale Sheep in Southwest Texas Conditions

Twenty-four Corriedale ewes were bred to registered Rambouillet rams this year. Fifteen of the ewes dropped lambs, which is a 62.5 per cent lamb crop, as compared with 81.3 per cent for the registered Rambouillet ewes. The average weaning weights of the cross-bred Corriedale-Rambouillet ewe lambs was 47.3 pounds as compared with 49.6 for the registered Rambouillet ewe lambs, and 53.6 pounds for the cross-bred Corriedale-Rambouillet ram lambs as compared with 52.4 pounds for the registered Rambouillet ram lambs. The Corriedale aged ewes sheared an average of 8.1 pounds of wool, while the registered Rambouillet aged ewes sheared an average of 10.0 pounds. The yearling Corriedale ewes sheared 8.8 pounds, while the registered Rambouillet yearling ewes sheared 7.9 pounds. The health and thriftiness of the Corriedales for the year have been somewhat better than usual, but even so the Rambouillets show more hardiness and thriftiness under southwest Texas conditions. The two bands of sheep have been handled identically. The Division of Range Animal Husbandry will report on the complete notes and data taken on the two flocks.

J. M. Jones, W. H. Dameron, B. L. Warwick.

Inheritance in Angora Goats

This work embraces flat and ringlet type fleece in Angora goats. Systematic line breeding and cross-breeding of the two types are necessary. Detailed breeding records include (1) birth weight of kids; (2) weaning weight; (3) weights at 1 year, 2 years, 3 years, etc. as long as the goats are in the flock; (4) grease and clean weight of fleece; and (5) quality or fineness of fleece as determined by the diameter measurements of fiber samples taken from the shoulder, side, and thigh, once a year for each breeding animal as long as it is retained in the flock. This year 178 registered Angora does which were bred to 3 registered Angora bucks were used. Detailed records are kept of each individual. Results are reported by the Division of Range Animal Husbandry.

J. M. Jones, B. L. Warwick, W. H. Dameron.

Sheep Inheritance Studies

It is important to know the difference in production of lambs and wool from the two predominating types (B. & C.) of Rambouillet sheep as produced in this region of the country. For the work this year 182 head of registered Rambouillet ewes bred to 14 head of regis-

tered Rambouillet rams were used. There is a predominance of C-type animals in the Station flock. The ewes are shaped up in the fall prior to the breeding season for mating with designated rams suitable for the study of body type and wool production. The lambs from these matings are studied through data on (1) individual breeding weights of ewes and rams; (2) lambing weights, including birth weights of lambs; (3) weaning weights of lambs; (4) individual fleece weights (both grease and clean) of all breeding animals retained in the breeding flock; (5) score or rating of each individual comprising the flock; (6) evenness and fineness of fleece as determined by samples taken from shoulder, side and thigh once annually; and (7) records of body type and conformation. These records are taken immediately before and after shearing in the spring.

Complete data on this work are analyzed by the Division of Range Animal Husbandry, by which it will be reported.

J. M. Jones, B. L. Warwick, W. H. Dameron, S. P. Davis.

Crutching or Tagging of Bred Rambouillet Ewes

Fleece worms cause considerable trouble in sheep in long wool in this section of the country in the spring of the year, more especially if there is dampness and humidity. In an effort to eliminate this trouble, the advisability of crutching or tagging sheep deserves some study. There is also the factor of submitting for sale wool which is free of tags and sweat locks. Where sheep are lambed loose in pastures, it is also of value to have the wool clipped from around the udders of the ewes to prevent a certain percentage of lambs from starving to death by nursing on the tags and sweat locks. For this work this spring we tagged 180 head of registered Rambouillet ewes, aged, by clipping the wool from around the tail-head, down the britch, and around the udder. The amount of tags per ewe averaged .71 pound. From 32 head of registered Rambouillet yearling ewes tagged in the same manner, an average of .47 pound was clipped. The tags were sent to the Wool Scouring Plant for scouring data. A report of the analysis of data on this work will be made under the Division of Range Animal Husbandry.

W. H. Dameron, J. M. Jones, S. P. Davis.

Shrinkage Tests on Wool and Mohair

During the year this Station collected from the registered sheep 301 fleeces of wool which were sacked individually and marked for identity; similarly it collected 71 fleeces from registered Angora goats. These were sent to the Wool Scouring Plant at College Station for scouring and shrinkage tests. The fleeces from thirty-nine aged grade ewes were also sent for shrinkage tests. This work will be reported by the Division of Range Animal Husbandry which has compiled all of the data.

W. H. Dameron, S. P. Davis, J. M. Jones.

Screw Worm and Fly Repellent Study

Screw worm infestation among livestock in the stock raising area of Texas constitutes a major problem of the livestock raising industry. It is estimated that this menace alone is responsible for \$8,000,000 to \$10,000,000 annual loss. Considerable work has been done by the Federal Government in an effort to control the blowfly and thus reduce the livestock loss, but it is generally conceded that there is an enormous amount of investigation yet to be done to accomplish the desired results. Some work has been done at this Station in this connection in cooperation with the U. S. Department of Agriculture Bureau of Entomology. This year the Federal Department built a screened fly house here, 30 feet long by 20 feet wide, to study the healing of screw worm infested animals through the fly house as compared to the "wormy trap" method.

To compare the fly repellent action of Pine tar oil with bone oil, six calves were dehorned on July 10, this year. On three of them Pine tar oil was used as a repellent throughout while on the other three bone oil was used. All of the calves in both groups were healed by August 24. During the time between dehorning and being healed the bone oil group had 12 cases of fly blows, 6 cases of screw worms, and received 25 applications of the repellent. The Pine tar group had 33 cases of fly blows, 10 cases of screw worms, and received 32 applications of repellent.

W. H. Dameron, O. G. Babcock.

Fire Brands vs. Chemical Brands for Cattle

It is claimed by some manufacturing concerns that it is safer and more humane to brand livestock (cattle) with a chemical branding fluid than with a hot branding iron. To make a comparative study of the two methods of branding, three calves, ranging from four to twelve months old, were branded according to instructions of the manufacturer of a chemical branding fluid on July 10. A like group of three calves were branded on the same date, same place, and with the same size brand with the hot branding iron.

In the chemical branded group the first calf branded was peeled and well on August 21, the last one on September 7. The brands started peeling July 22; as the brands peeled they left a raw-looking wound under the thick scab as it came off. During the time of peeling one calf got screw worms in the brand and had to be doctored to kill the worms.

In the fire-branded (hot iron) group, peeling started on July 22 and one calf was completely peeled and healed on August 12. The last one was well on August 21. None of the calves had any complications in their brands.

W. H. Dameron, J. M. Jones, O. G. Babcock.

Cottonseed Meal and Salt Feeding for Lambs

A considerable amount of interest has been manifested in feeding sheep various mixtures of cottonseed meal and salt to control poisonous plant troubles and promote growth in young stock. As requests for information on the subject continue to come in, this year we placed 97 lambs on a mixture composed of 400 pounds of cottonseed meal, 60 pounds pulverized oystershell and 40 pounds salt. The test was started February 5, when the range was dry and sheep were showing some shrinkage. It was ended on March 4 after receiving a good rain on March 2 that greatly improved the range conditions.

At the beginning of the test the 97 lambs had an average weight of 67.9 pounds, while at the end the average weight for 94 lambs was 79.3 pounds, or an average gain of 11.4 pounds. Three lambs were omitted on account of unthriftiness.

During the feeding period the lambs consumed 1707 pounds of the mixture, or an average daily consumption of 10.26 ounces. This divided up in its component parts is as follows: .82 ounces salt, 1.23 ounces pulverized oyster shell, 8.20 ounces cottonseed meal.

W. H. Dameron, O. L. Carpenter.

Toxicity of Bitterweed (*Actinea Odorata*)

Investigation on the toxicity of bitterweed for sheep has been completed and a manuscript submitted for publication.

I. B. Boughton, W. T. Hardy.

Swell Head of Sheep and Goats

Previously reported experiments have shown that consumption of the buds and flowers of the sacahuiste plant (*Nolina texana*) by white skinned animals, combined with subsequent exposure of such animals to the sun's rays, produces the typical disease.

This condition is of much less common occurrence in the Edwards Plateau area than formerly as a result of the gradual reduction of the number of sacahuiste plants from heavy grazing.

I. B. Boughton, W. T. Hardy.

Hard Yellow Livers of Sheep and Cattle

The grazing trials, in which healthy sheep from this Station had been running on ranches where the hard, yellow liver disease occurred during 1931 and 1932, were discontinued early in the year under review. One group of 21 sheep, grazed continuously for 2 years on the affected

premises, remained healthy during this time. No new cases of the disease have appeared since late in 1931 throughout the region where the malady was prevalent at that time.

Vegetation surveys of the affected ranches brought one weed, *Aplopappus spinulosus*, under suspicion. Some feeding tests of this plant were completed and others are in progress. I. B. Boughton, W. T. Hardy.

Contagious Ecthyma (Soremouth) of Sheep and Goats

In several controlled tests mature sheep, vaccinated as suckling lambs, were still immune to experimental reinfection with soremouth virus after 34 to 44 months.

Potent bacteria-free soremouth virus did not grow when inoculated into the chorion of 22 fertile chicken eggs. All except two of the eggs hatched normally. The chorionic layers of the two eggs which did not hatch were emulsified in sterile normal salt solution and inoculated intracutaneously into soremouth-susceptible lambs, with negative results.

Potent bacteria-free soremouth virus was injected into the amniotic cavity of the uteri of two four-month pregnant ewes in an effort to produce a pure virus in the amniotic fluid. Despite careful attention to asepsis in both laparotomy and uterine injections, both animals died within two days after the operation.

I. B. Boughton, W. T. Hardy.

Stomach Worms (*Haemonchus Contortus*) of Sheep and Goats

In the longevity studies of infective *Haemonchus contortus* larvae on the range, two of the plots which were fenced and ditched in October, 1934, were found to carry infective larvae 22 months later. Bottle-raised, parasite-free lambs (one in each plot) were allowed to graze for 10 days and then removed to a concrete, parasite-free stall. These animals were killed 28 days later, and a careful search revealed two mature *H. contortus* in the abomasum of one lamb and one mature *H. contortus* in the other.

A group of 37 lambs, approximately six months old and heavily infested with *H. contortus*, were drenched with 2 ounces each of the standard copper sulphate-nicotine sulphate mixture (1¾ per cent copper sulphate and .8 per cent nicotine sulphate) without previous retention from feed and water. They were held off food and water for 6 hours after treatment.

A complete kill of stomach worms resulted in 29 animals (78.38 per cent) as determined by slaughter and autopsy two to four days subsequent to drenching, while the remaining 8 lambs (21.62 per cent) revealed heavy infestations with live stomach worms.

In a field experiment 492 ewe lambs (8 months old) were rounded up from the pasture and drenched immediately and then starved of food and

water for 9 hours. These animals showed clinical signs of stomach worm infestation and ten head, picked at random, showed an average of 3700 parasite eggs per gram of feces. Four days after treatment one lamb was slaughtered and 152 live *H. contortus* were found. Fecal count of ten lambs at this time showed an average of only 1480 parasite eggs per gram of feces.

A comparable control group of 480 mutton lambs were first starved of food and water for 24 hours and then treated in the same way. Fecal examination of ten lambs, selected at random, showed an average of 2700 parasite eggs per gram prior to treatment; four days subsequent to drenching these animals showed an average of 1480 parasite eggs per gram of feces. One lamb slaughtered the same day carried 300 live *H. contortus* in the abomasum.

One month later both groups of lambs were in excellent clinical shape, there being no distinguishable difference between them. The results would indicate that the period of "shrinking" prior to treatment for *H. contortus* infestation can be eliminated. The starvation period of 8 to 9 hours after treatment, however, should be continued.

Six 6-months-old lambs were fed a fattening ration for 91 consecutive days in a dry pen, the soil of which carried a heavy *H. contortus* larvae infestation. Three of these animals showed a very slight infestation (fecal examination) at the end of the feeding period while the other three lambs remained free of infestation. All of them were in excellent shape and gained normally throughout the entire time they were on feed. Six comparable control lambs were similarly fed for the same period in a pen known to be free from *H. contortus* larvae. At the expiration of the feeding period there was no appreciable difference between the two groups of lambs.

Three lambs recovered spontaneously within 6-8 months from clinical, artificially-induced stomach worm infestation. They were then placed in a pasture known to be infested with *H. contortus* larvae. Monthly examination of their feces were negative for 90 consecutive days, but a few eggs appeared after 120 days. The animals remain in excellent condition.

To confirm previous tests, six lambs were drenched with large doses of infective *H. contortus* larvae and allowed to develop severe clinical infestation. They were penned in concrete stalls which were cleaned daily. Weekly egg counts of the feces were made, starting 24 days after the larval drench. All showed a gradual increase in fecal egg counts for two months subsequent to the first appearance of eggs in the feces; this increase paralleled, practically, the clinical manifestations. After the peak of egg production a gradual decrease in number of eggs was noted in the weekly counts. Six months after the original infestation these lambs showed a great reduction in fecal egg count.

Two sheep, which had recovered from artificially induced infestation, were each drenched with 18,750 infective larvae at one dose approximately 100 days after their feces were negative for eggs. These animals

were held in parasite-free, concrete stalls, and eggs were again found in the feces some 26 days later. Three months later neither of these animals had developed clinical signs of infestation and their egg counts remained consistently low.

Seven lambs, approximately 6 months of age and in good condition, were drenched with large doses of infective *H. contortus* larvae. Thirty days later all these animals were excreting many eggs in their feces and were showing clinical signs of infestation. They were each given a gelatin capsule containing 1500 milligrams of powdered pyrethrum flowers, without a previous "shrinking" period.

These animals were slaughtered 4 to 6 days after treatment and all of them were found to be carrying a large number of live *H. contortus*.

I. B. Boughton, W. T. Hardy.

Miscellaneous Feeding Trials of Suspected Plants

Three sheep were fed 2.85 per cent, 1 per cent, and 2 per cent, respectively, of their body weight daily of fresh, green, basal-rosette growth of cone flower (*Lepachys columnaris*) for 7, 54, and 54 consecutive days. All remained healthy.

One healthy sheep consumed 2 per cent of its body weight for 5 days of the fresh green leaves of *Dalea lasianthera* without ill effects.

Three mature sheep were fed fresh chopped prickly pear (*Opuntia Engelmannii*). The animals were started on two pounds of prickly pear each per day and gradually raised to 12 pounds, where they were held for a period of 50 days. Aside from a temporary diarrhea during the first week the animals remained healthy.

Two sheep consumed 1¾ pounds of ground oak leaves mixed with cottonseed meal for 109 consecutive days. The sheep lost some weight on this ration, but otherwise showed no ill effects.

I. B. Boughton, W. T. Hardy.

Infectious Entero-Toxemia of Young Lambs

Losses of suckling lambs, fat, in excellent shape, between 4 to 10 weeks of age, were reported from practically all parts of the sheep country. A few outbreaks were also reported among fat kids.

Symptoms comprised loss of appetite, slight temperature elevation, panting, slobbering, recumbency, coma, and death. The lamb usually succumbed within 2 to 8 hours after manifesting symptoms. The lesions are characteristic consisting of pale, pulpy kidneys, and a friable, tan-colored liver, endocardial and epicardial ecchymoses, together with occasional ecchymoses in the abomasum and small intestine.

Autopsies of several typically affected animals and subsequent bacteriological studies of material from their carcasses proved that the condition was a toxemia resulting from the absorption of the soluble toxin secreted by *Clostridium Welchii* which was found in practically pure culture in the small intestine.

Sterile filtrates of small intestinal contents were toxic for rabbits and suckling lambs.

Dried toxins from meat mash cultures tested against four types of *Cl. Welchii* antitoxin demonstrated that the toxin is that of Type D. This is the first time that the *Cl. Welchii*, Type D toxemia has been reported in this country.

Experiments looking toward prevention by vaccination, using ana-cultures or anatoxins, are under way at the time of this report.

I. B. Boughton, W. T. Hardy.

Bone Meal and Salt Feeding Experiments

There was no difference in health and fleece weight in three mutton sheep running on the range and being fed a measured amount of bone meal-salt mixture (equal parts of each) three times weekly, and three comparable muttons running in the same pasture and receiving measured amounts of plain salt three times weekly.

The determinations of the serum calcium and inorganic phosphorus in the blood of sheep and cattle running on the range and licking, free choice, a 50-50 mixture of bone meal and plain salt, made at six-month intervals during the year, showed no appreciable variation in amounts from similar blood determinations made at the same periods in a comparable number of control sheep and cattle running in comparable pastures and licking plain salt free choice. The bone meal-salt mixture cows raised a larger calf crop than did the control group but there was no difference in the lamb crop in the two groups of ewes. This is the second year of this experiment.

I. B. Boughton, W. T. Hardy.

Laboratory Specimens

Specimens, experimental and diagnostic, to the number of 852 were handled during the year.

I. B. Boughton, W. T. Hardy.

Range Botany

As stated in the preceding report the manuscript of the check list of the plants of Texas was completed and submitted to the Publication Committee this year.

Further progress has been made in recording the distribution of various species of plants, but various discrepancies still exist. One that has been noticed is that with 75 species of the genus *Carex* recorded for the State, not a single species has been found in Division 3, the Rio Grande Plains, although there must be a few species of this genus growing in that area. With the publication of this plant catalogue the filling in of the deficiencies in distribution will be greatly facilitated.

During the year, together with Mr. H. B. Parks, a few plant collecting trips were made. In March we attended the first scientific field trip at Palmetto State Park in the Ottine Swamp area. In April we attended the sectional meeting of the Texas Academy of Science at Alpine, and took occasion at that time to make plant collections in the Glass, Davis, and Chisos Mountains. We added 4 species to those growing in Texas as previously known, three being from the Glass Mountains and one from the Chisos Mountains; and two other species were collected for the first time in our personal experience. In September a trip was made to the Big Thicket area of southeastern Texas. It now seems that we shall have three or four new species of plants to be described from that area, and two or three others were added to our list through finding them growing there. Not much more than half as many specimens of plants were collected this year as in the preceding year, but to an unusual extent many interesting specimens were taken.

During the year the determination, numbering, and listing of the 5649 sheets of plants collected in the year of 1935 were completed. This involved 3,555 sheets of the collection of that year. In addition to this a start was made on the plant collections of the present year, and 1462 sheets of the same were determined, numbered, and listed. Together these amount to a total of 5,017 sheets of plant specimens worked up this year. About one-half of the plant collection of this year yet remain for working up. In this material of the two years of collection some eight or ten new species have been found. Detailed descriptions have been written out for all these, but drafting same into final manuscript form has not yet been accomplished.

In connection with the regular vegetation studies of the range, 126 quadrat counts were made during the year: 30 in three pastures of the Ranch Experiment Station, 36 in two pastures of Aldwell Bros. in southwestern Sutton county, 33 in one pasture of C. B. Metcalfe, along Spring Creek in southwestern Tom Green county, and 27 in two pastures of Tom Holiman, three miles east of San Angelo, Tom Green County. In the latter case two of the quadrat sites were submerged at the time of heavy rainfall in September and counts could not be made of these the last three months of the year. The September counts in Tom Green County could not be made because Highway No. 30 was blocked by deep water in two or three lakes south of Eldorado. The regular 46 quadrat counts in connection with the study of *Actinea odorata* were made this year early in June.

Considerable travel was made with the veterinarians, some for the purpose of inspecting ranges where forage poisoning of livestock was suspected and some for the purpose of collecting plant material for experimental feeding of livestock in studies along this line. Detailed reports of these matters will be made by the veterinarians.

Botanical descriptions of *Sophora secundiflora* (Ort.) Lag., and of *Agave lecheguilla* Torr. were prepared for the use of Dr. F. P. Mathews, of the Loco Weed Laboratory at Alpine, in bulletins reporting his work with these two plants. Properly the first one was prepared for Dr. I. B. Boughton.

Two papers written the preceding year were published this year. These are: "A New Columbine from the Edwards Plateau of Texas," which was published in the February issue of the botanical magazine *Rhodora*, and "Three Junipers of Western Texas," which was published in the May number of *Rhodora*.

A manuscript entitled, "The Occurrence of *Talinum Pulchellum* in Texas," was accepted by the botanical magazine *Madrono* for publication, and should appear in print during the year of 1937. This manuscript was made possible by finding this plant in the Glass Mountains, and two or three weeks later, finding it on top of Mt. Livermore, and then growing these plants under cultivation. Our work cleared up existing confusion regarding this species.

Publication was made in the November number of *Rhodora* of a series of new names and new combinations of names for Texas plants, preparatory to the use of these names in the proposed publication of "A Catalogue of Texas Plants."

A popular article entitled, "Maintaining Desirable Vegetation on the Range," was published in the Southwestern Sheep and Goat Raiser, Vol. 6, No. 9, February 1, 1936. This article, as published, was well illustrated.

At the close of the year a popular article entitled, "Our Important Range Plants," was submitted for publication in a special issue of the *San Angelo Standard-Times* to appear February 3, 1937.

The quadrat count studies on the ranches of Aldwell Bros., C. B. Metcalfe, and Tom Holiman. It seems desirable that one or more general observations annually should be made on these ranges, at least until the work already done has received its final analysis. It is thought desirable to continue the quadrat counts in the three pastures of the Ranch Experiment Station.

V. L. Cory.

Insects Affecting Animals

(In Cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture.)

Goat Louse Investigations

Dipping experiments on a more or less extensive scale were carried on in cooperation with the State leader, W. R. Nisbet, and several county agents in Texas and Dr. W. L. Black of New Mexico. Wettable sulphur, having a standard of 98 per cent passing 298-325 mesh screen, was used in all experiments. The capacity of the vats used ranged from 248 gallons to 2000 gallons. Abandoned cattle vats were used in many cases; in others, the old abandoned cow vats were partitioned off so that the outlet end could be used as a goat dipping vat. This proved quite satisfactory and was successful. No two vats were alike in shape, convenience of operation, pen arrangements, draining pens, etc. A few round vats were also used. In general, the experienced ranchmen had the best pen arrangements, and in a few cases, it would hardly be possible to plan more inconvenient and awkward arrangements.

Whenever used, the round vats gained favor very rapidly.

During the past year 20,209 head of goats were successfully dipped once or 40,418 dipped twice in elemental sulphur dips, with exceptionally good success.

The mohair was greatly improved in quality, quantity, lustre, and oiliness three or four months after dipping. The greatest improvement may be shown after the first shearing following dipping. It appears, although difficult to prove, that the elemental sulphur dips certainly impart a beneficial effect upon the fiber and healthfulness of the animal. The lice were all killed in from four to ten days' time, depending mainly upon air temperature and the activity of the animals.

The death losses were all traced down to a few points as follows:

1. Animals heavily infested with internal parasites at time of dipping.
2. Anemic animals cannot well withstand the excitement and rough handling during the dipping operation.
3. Animals of old age, about ready to die, toothless animals, etc.
4. Carelessness in the dipping, that is, not allowing an animal to get its breath before being ducked the second and possibly the third or fourth times.
5. Shallow dips in a deep cattle vat. Rough handling of animals, that is, throwing them against the side walls, then ducking them while the animals are out of breath.

State	County Agents	Number ranchmen dipping goats	Number present at dipping	Number dippings	Total number animals dipped	Length of fiber inches
Texas	17	32	200±	2	18,039	1.25 to 4.50
N. M.	2	*** 4	12	2	2,170	* 2.5
Total	19	36	212±	**** 2	** 20,209	1.25 to 4.50

* No loss of animals in New Mexico; altitude had no effect on killing properties of sulphur so far as could be determined.

** Two dippings totaled 40,418 head actually dipped which gave an excellent kill; increase in weight of mohair of one-fourth to one-third pound per animal; oiliness or life of fiber; and a healthier and more active animal.

*** Eleven new round vats have been constructed in New Mexico as result of dipping experiments.

**** Average.

High and low altitude, so far as experience goes, has no effect upon the killing or toxic properties of sulphur.

Lime waters are quite tolerable to the elemental sulphur, but the Na_2SO_4 alkali water causes considerable trouble in holding the sulphur in suspension.

MgSO_4 alkali waters gave the greatest amount of trouble. Either the sulphurs are precipitated out, or great difficulty is experienced in holding the sulphur in suspension.

The addition of Na_3PO_4 in considerable amounts helps to correct this condition, but not very well until soap or other wettable agents will have been added.

Sodium phosphate by itself is not a good wettable agent, but when mixed with animal and vegetable oil and alcohol soapless detergents, excellent wettable sulphurs may be made. Work along this line is still under way; however the work thus far shows the following formulas to be very good wetting agents:

Water 350 cc. and 325 mesh, 99.8 per cent pure non-wettable elemental sulphur used in each test.

Formula No. 1

Sodium oleate, neutral base5 gms.

Powdered waterproof wood glue5 gms.

An alcohol soapless detergent5 gms.

Time to settle after agitation, 5 to 8 minutes. Barely stuck on bottom, an advantage.

Formula No. 2

Powdered waterproof wood glue5 gms.

An alcohol soapless detergent5 gms.

Sulphur stuck on bottom, a disadvantage. Time to settle, $5\frac{1}{2}$ minutes.

Formula No. 3

Sodium oleate, neutral base5 gms.
Powdered waterproof wood glue5 gms.
Sulphur stuck on bottom. Time to settle, 8 minutes.

The above formulas were used in a semi-hard deep well lime water. The advantages of the formulas are listed as follows:

Formula No. 1

Surface of the water soapy. All sulphur in suspension.

Formula No. 2

Mixes with water right away. No sulphur on surface.

Formula No. 3

Surface of dip soapy; all sulphur in suspension.

Sheep Louse Investigations

The well-known body or biting louse of the sheep, *Bovicola sphaerocephalis*, is not common and is seldom seen. When present, it seems to prefer animals with the least amount of oil. The karakul sheep are especially susceptible. These biting lice have been observed to be abundant on individual animals of the Merino, Rambouillet, and Navajo breeds of sheep.

It requires thirteen and one-half months from time of infestation to maximum or heavy infestation as observed on two infested animals. It also required from the maximum to a low infestation seven months. The other animal used, having more immunity, only developed a medium infestation after a period of four months. This infestation subsided to almost zero within one and one-half months and remained so four and one-half months longer, or until the animal died.

"Grub-in-the-Head" of Sheep and Goats

Pressure of other work and shortage of funds greatly retarded and handicapped this problem. The minimum pupal periods proved to be less than one month and two days and ten days. One heavily infested flock, as reported from Victoria, Texas, was found to be heavily infested with the liver fluke instead of *Oestrus ovis*.

An instrument for administering the drugs to the sinuses of the head has been developed. Eight chemicals are yet to be tested; four others looked promising after tests were made; and fourteen have been eliminated as of no value when used against this parasite. The promising chemicals are ethylene dichloride, tetrachlorthane, propylene dichloride, and amylene dichloride.

Head examinations of sheep and goats, all ages, for all stages of larvae are given in the following table:

Animal	Animals		% In-fested	Number of larvae				No. of dead larvae	Total number larvae	No. Months of year collected
	In-fested	Not in-fested		1st instar	2nd instar	3d instar	Black stage*			
Angora Goat	30	70	30	10	41	51	11	2	102	8
Ram-bouillet sheep	137	47	74.45	257	414	522	78	40	1193	12

*All black stage larvae are included in the 3rd instar count.

Dead larvae usually mature or late stage third instars have been found in the blind pouch of the inferior turbinate bones, frontal sinuses, and in the blind sinuses of the superior or upper maxillary bones; when found in the latter they have been noticed to be hard or semi-ossified. All indications are that these dead larvae migrate down or out and find the blind pouches by chance and there remain until death. Usually dead larvae are associated with a cold in the head, thus shutting off the air supply, and death is apparently caused by suffocation.

Not a single animal seriously suffering from the "grub in the head" of sheep has been observed during the past twenty years' observation on the range or in the pens. It thus appears that this parasite is apparently not a serious pest to sheep and goats. Not a single authentic death from *Oestrus ovis* has come under our observation during the past twenty years. All cases investigated have been traced to intestinal parasites or other troubles.

Screw Worm Fly Investigations

C. americana

The electric fly trap did not prove itself as of any advantage over the government trap when trapping for blow flies, but there may be possibilities along this line of barn window protection.

Larvae collected from wounds of animals during the winter of 1935-1936 proved to be *Phormia* species (black or winter blow fly), except one *Lucelia* and one *C. americana* (primary screw worm fly) from Brackettville, Texas. The pupal periods of *Phormias* ranged from 15 to 67 days. The *C. americana* pupae required 28 days for emergence. The larvae of *Phormias* were collected from wool; chest, tail head, marked lambs, and ear tag wounds of sheep.

Over-wintering tests made during winter of 1935-1936 showed that none of the flies passed through the winter. Winter started early in

1936; nevertheless thousands of larvae and pupae of *C. americana* were either buried or allowed to bury themselves in the soil. All experiments are in cages and well protected. Larvae were allowed to leave infested animals naturally and they were also bred on medium and allowed to enter the soil at will.

During cold and frosty weather *C. americana* larvae are chilled almost immediately after leaving the wound and are motionless, many larvae remaining in among the wool fibers.

C. americana larvae that had entered the soil in the screen house pupated. The adult primary screw worm flies began emerging on January 1, 1937. The soil temperature ranged from 50 to 69° F. The soil moisture amounted to only 19.05 per cent whereas in the cloth houses the native soil moisture amounted to 30.6 per cent. No flies have emerged from the cloth houses.

Hot Iron vs. Potash Branding of Cattle

The hot iron branding was done by an experienced cowhand, while the potash branding was done exactly according to the directions of the manufacturers and with their own branding iron made for the purpose.

The summary of the results shows that on the average the hot iron brands were healed and the animals released on the 49th day; minimum 41 days and maximum of 63 days. The chemical brands did not completely heal so that the animals could be released until an average of 54 days; minimum 47 days and maximum 59 days. The chemical brands were 4.7 days slower in healing than the hot iron brands.

If one is not very careful, the hot iron brands can be over-burned; and the chemical brands can be still more injurious. All factors considered, the hot irons seem preferable.

Bone Oil

The first findings of bone oil by a veterinarian in California, now deceased, forced some immediate work with this chemical.

It is a very complicated product made from the distillation of bones and more than likely varies to some extent in its chemical composition, but in general remains fairly constant when made in large quantities.

The special merit of bone oil seems to be on fresh cuts, such as shear cuts, docking, castration, dehorning, etc. Its healing properties are very marked as well as its odor. When applied on old "wormy" cases, more extensive work needs to be done. There may also be a variation in result between summer and winter climatic conditions. Cuts artificially made and treated by Dr. I. B. Boughton daily had to have the wounds broken open. Apparently no absorption occurred. All reported

cases investigated were traced to "so and so said it was poisonous," or the animals died of stomach worms or something else, but the bone oil got the blame.

A yearling lamb was wounded twice by the author; one cut on hip and the other near flank but through the peritoneum into the body cavity. The latter wound was immediately treated with bone oil until healed. The hip wound was heavily infested with screw worms; later bone oil was applied to living larvae and the wound daily until healed. No absorption or poisoning was observed. Animal healed in excellent condition.

Winter Tick

Winter ticks collected early in 1935 showed a record of 46 days before egg deposition; egg laying period 35 days; egg incubation 92 to 127 days; longevity or starvation period of seed ticks 233 days.

The Devil's Shoe String, a Texas wild weed, 95 per cent passing a 200 mesh screen, was used on a ticky work horse. The entire animal was dusted by rubbing the powder well into the skin. The animal was being worked on the fresno. After two days time 99 per cent of the ticks were dead and none found after the tenth day. The animal improved right away and grew a new coat of hair. No adult ticks were present. A similar test was made during the winter of 1936-1937. The horse was literally covered with the Winter tick. In four days time, practically all ticks were gone and none to be found by the tenth day. Nine and one-half ounces of the powdered Devil's Shoe String was required to treat this work horse.

O. G. Babcock, Bur. Pl. Ent. and Quar.

SUBSTATION NO. 15, WESLACO

Substation No. 15 is located in the Lower Rio Grande Valley. The Substation farm consists of 100 acres of land lying about midway between Weslaco and Mercedes on the Missouri Pacific Railway. The area served by the Valley Station is the irrigated fruit and vegetable producing region in the extreme southern part of the state. A large portion of the program of this station is devoted to a study of the problems pertaining to the citrus fruit industry. The program of the station also includes research work with vegetables, field crops, ornamentals, sub-tropical fruits, crop pests, and diseases.

Experiments With Citrus Fruits

Grapefruit Production: Trees in the sixteen-year old Marsh grapefruit orchard, that have been used for various orchard management studies, showed considerable improvement this season. Superior tree

condition appears to be more closely associated with desirable soil type than with any of the various soil treatments. Tree thinning, which was completed last year, has not resulted in marked improvement in the condition of the remaining trees. Trees in the unthinned portion of the orchard are comparable in condition to the trees with more space, bore more fruit per tree, and the fruit was of superior quality. The average size of the fruit was smaller on the closely spaced trees, but total yields of marketable fruit were considerably higher from the unthinned trees.

Citrus Variety Adaptability Tests: Yields of fruit from trees in the variety test orchard were quite high this season. Navel orange trees were less productive than other varieties this season but the larger Navel orange trees produced well over 500 pounds of fruit per tree. Of the grapefruit varieties, Pink Marsh (Thompson) grapefruit on Cleopatra Mandarin root stock was the most productive tree in the orchard, yields ranging well above 1200 pounds per tree. Trees of the Duncan and Foster varieties set rather light crops, and the fruit was too large and coarse to be desirable. However total yields for these varieties ranged rather high. Two-year old trees of Ruby grapefruit fruited this season and the fruit showed the characteristic outside blush and spectrum red flesh color, indicating that the second (buddling) generation of this valuable bud sport is reproducing the desirable characteristics of the parent limb. The ten-year old trees of Hamlin orange bore yields of fruit comparable with those from good grapefruit trees of similar age and superior to those from trees of other orange varieties. Orange trees of the Joppa variety also produced excellent yields of fruit this season. These two varieties, because of their desirable quality, relative seedlessness, and productive capacity, are recommended for Valley Planting. Satsuma oranges of the Owari variety on Rusk Citrange root stock produced abundant yields of fruit of exceptional quality. The fruits ripen early (October), are relatively seedless, and have tender, deep orange flesh, but lack the high skin color shown by the Dancy and Clementine tangerines. Trees of Clementine tangerine bore heavy crops of fine fruit that was ready for market in late October. Trees of this variety are more vigorous and the fruit is superior to either Warnurco or Dancy. A ten-year old Meyer lemon, on its own roots, produced slightly more than a thousand pounds of fruit this season. Lemons of this variety sold readily during the fall season.

Of the acid fruits, trees of Mexican lime, Rangpur lime, Calamondin, Lakeland and Tavares limequats produced abundant yields. In the specialty group, Temple oranges and Thornton tangelos deserve special mention because of their exceptional flavor and the productive capacity of the trees.

Citrus Fertilizer Tests: In the old grapefruit fertilizer-test block, trees which have received ten annual applications of bone meal at the rate of ten pounds per tree (1000 pounds per acre) are superior to other trees in this block, from the standpoint of both appearance and yield. A border row of trees, adjacent to an Athel hedge, that has

received complete fertilizer during the past ten years, is equally as good.

Yield records have not been completed in the ten-year old Marsh grapefruit grove that has received four annual applications of fertilizer in which nitrogen alone is being compared with nitrogen and phosphoric acid in combination and with nitrogen, phosphoric acid, and potash. Each tree in this test receives one pound of nitrogen annually. The crop on trees in this block is below average, in both quantity and quality, and the trees are not in the best condition as shown by leaf size and twig growth.

Citrus Root Stock Studies: Grapefruit seems to thrive equally well on sour orange, Cleopatra Mandarin, and rough lemon, and young trees on Rusk Citrange are quite productive and hardy. Seedlings of five selected strains of sour orange and one strain of sweet orange were budded this season. Seedlings of all strains developed rapidly and made satisfactory stocks for budding within nine months from the time they were transplanted, or eighteen months after the seeds were planted. In a seed bed planting of Brazilian Sour, Standard Sour, Oreville Sweet, Hamlin, Weldon Sweet, Texas Navel, Raymondville Sweet, Triumph grapefruit, and Chinese pummelo, Raymondville Sweet made outstanding growth, while seedlings of Triumph grapefruit were a close second. Seedlings of Hamlin orange are slightly weak.

Citrus Orchard Reclamation Studies: Both bulky organic matter and complete fertilizer (10 pounds per tree of 10-30-10) have produced marked changes in the appearance of 16-year old, decadent, grapefruit trees during the past four years. Trees on these plats have the general appearance of thrifty, young trees. The leaves are large, dark green in color, and are borne on new growth that averages 12 inches in length. The fruit was large, coarse, and much greener than that from other trees in this block. The bulky organic matter (hay) applied at the rate of 500 pounds per tree, and gradually worked into the soil, was fully as effective as the complete fertilizer in rejuvenating these old trees.

W. H. Friend, J. F. Wood.

Citrus Progeny Studies: Six-year old grapefruit trees in the oldest progeny test grove produced excellent yields of fruit this season. The average for the block was well over 700 pounds per tree. Variation within groups is almost as great as between groups of progenies of selected parent trees. Variation between trees due to storm injury in 1933 should become equalized by next season, as the trees are now quite uniform in appearance.

There was wide variation in the yields from trees in the four-year old grapefruit progeny test, represented by eighteen selected parent trees. The fruit yield records have not been completed but it is obvious that there is wide variation within the progeny groups, as to both quality and quantity of fruit produced. Quality of fruit (smoothness and

texture) appears to be closely associated with the amount of fruit per tree rather than with any inherited factor or factors.

Citrus Storage Tests: Cold storage experiments with Valencia oranges and Duncan grapefruit were continued during the 1935-1936 season. Very satisfactory results were obtained at a temperature of 45°F. with both Duncan grapefruit and Valencia oranges. Wrapping, even with plain tissue, reduced losses due to shriveling during a ten weeks' storage period. Aluminum foil wraps kept grapefruit and oranges in perfect condition when stored at room temperature for a period of ten weeks. Fruit removed from cold storage and held at room temperature for several weeks remained in perfect condition where aluminum foil wraps were used.

Supplementary tests during the 1936-1937 season showed that moisture-proof cellophane is about as effective as aluminum foil in preventing the deterioration of thin-skinned varieties of citrus fruits. Cellophane bags were about as effective as individual wraps in preventing shrinkage of early varieties of citrus.

W. H. Friend.

Citrus Washing, Coloring and Wrapping Tests: Pre-storage treatments, such as gassing with ethylene or stove gas and a humid storage temperature of 80°F., accelerated coloring, decay, and shriveling in the case of Meyer lemons, tangerines, and Navel oranges. Gassing and heating were found to be unnecessary for the coloring of wrapped Meyer lemon fruits. Fully mature fruits of this variety showed full color 10 days after wrapping in tissue, cellophane, or foil. Unwrapped fruits did not color so well, and losses due to shriveling were quite high.

None of the washes used was injurious but they had little effect in reducing losses due to stem end rot.

W. H. Friend, J. F. Wood.

Citrus

Citrus Variety Descriptions: Detailed physical measurements, such as diameter and depth of fruit, stem and blossom-end shape, rind thickness, number of segments, regularity of segments, number of seeds, and volume of juice were made on five varieties of oranges during the 1935-1936 fruit season. Thirty fruit samples were used in each instance. The varieties described were Texas Navel, Washington Navel, Joppa, Homossasa, and Pineapple. During the 1936-1937 season, Joppa and Satsuma oranges, and Foster, McCarty, and Thompson Red Blush grapefruit were described.

J. F. Wood.

Factors Affecting the Maturity of Grapefruit: Detailed physical and chemical measurements were made on samples of Marsh fruit from orchards located in several sections of the Valley during the 1935-1936 fruit season. In the study of the changes occurring in the per cent of

rind, rag, and juice by weight, as the season advanced, it was found that the seasonal trend of the per cent rind was relatively a straight line, the seasonal trend of the per cent rag was downward, and that of the per cent juice was upward. A definite correlation was found to exist between the decrease in the per cent rag and the increase in the per cent juice as the season advanced.

In the studies of the chemical changes occurring in the composition of the juice as the season advanced, it was found that the total soluble solids as degrees Brix approximated a straight line, the seasonal trend of the per cent citric acid was downward, and that of the Brix to acid ratio was upward. The seasonal trends of the per cent invert sugar and the per cent total sugars as invert were upward. The per cent sucrose did not show any definite upward or downward trend. The ratios of invert sugar to acid, sucrose to acid, and total sugars to acid showed general upward seasonal trends.

The pH increased slightly as the season advanced but the trend was not as definite as it was with some of the other measurements. The buffer indices, as determined from the pH, did not show any definite seasonal trend.

The total solids content, as determined from degrees Brix and the Brix to acid ratio in conjunction with a volume of juice requirement, appear to be the most practical and the best measures of grapefruit maturity found thus far.

J. F. Wood, H. M. Reed.

Citrus Crosses: A large number of crosses between different varieties and kinds of citrus was made. The following crosses were successful: Valencia orange selfed, Pineapple orange crossed with Pink Marsh grapefruit, Thornton tangelo selfed, Valencia orange crossed with Citron, Satsuma orange crossed with Pink Marsh grapefruit, and Satsuma orange crossed with Hamlin orange. Eighty seed resulting from the above crosses have been planted. Eighty-seven seedlings are growing at present from crosses made the previous season. These crosses are: Ruby orange x Meyer lemon, Thornton tangelo x Clementine tangerine, Thornton tangelo x Pink Marsh grapefruit, Pineapple orange x Pink Marsh grapefruit, and Valencia orange selfed.

Citrus Orchard Heating: During the winter of 1935-1936 the size of the heated area was increased from seventeen and one-half acres to one hundred acres. Two types of oil heaters were used. The heating was done in three separate blocks of trees. One block was of Eureka lemons, the other blocks were grapefruit and oranges mixed, the greater proportion of the trees being grapefruit. The heaters were fired two nights in succession, and no difficulty was experienced in maintaining the temperature above freezing. The temperature outside the heated area both nights was below freezing but very little damage resulted due to the

dormant condition of the trees and cloudy weather following. This work is being done in cooperation with Engleman Gardens, Inc.

Maturity Comparisons of Various Citrus Varieties: Studies were made of the relative maturity of several orange, tangerine, and grapefruit varieties. Analyses were made at two-week intervals throughout the season. The total soluble solids were determined by means of a Brix hydrometer. The acid was determined by titration with sodium hydroxide, and the solids to acid ratio was determined by calculation. The varieties of oranges used were Texas Navel, Washington Navel, Hamlin, Parson Brown, Pineapple, and Joppa. The tangerine varieties were the Algerian and Dancy. The grapefruit varieties were Little River Seedless, Marsh, Thompson, Foster, Duncan, and McCarty.

J. F. Wood.

Experiments With Date Palms

(In Cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

Variety Adaptability Studies: The permanent garden consists of 155 palms, 100 of which are from California and 55 from Iraq. The remainder of the palms on the station are planted in a nursery consisting of 22 palms, 5 of which are from California, 13 from Iraq, 3 from Arizona, and 1 from a Texas seedling.

The station collection consists of twenty-five varieties as follows: Maktoom, Halawy, Thoory, Zahidi, Saidy, Saffria, Dubiani, Hayany, Amir Haj, Khatuni, Deglet Noor, Tazizaoot, Okhat Fteemy, Jeffary, Bedraya, Khadrawy, Shukker Nobort, Khasab, Kustawy, Tadala, Sayer, Ashrasi, Bahrab, Dayri, and Braim.

Propagation of Date Palms: No offshoots were removed during the season. Only three palms bore fruit, all of which shattered and soured before ripening. The three palms were of the Tazizaoot variety. Relatively few palms bloomed in this section in comparison to former seasons. Continued cold weather throughout the winter and spring months apparently prevented the proper development of fruiting buds.

J. F. Wood.

Experiments with Vegetable Crops

Bean Variety Test: During the fall season of 1935 and the spring season of 1936, four varieties of snap beans were grown for the purpose of determining their adaptability. The two "new" varieties, Asgrow Stringless and Stringless Black Valentine, were compared with Bountiful and the standard sort, Giant Stringless. Asgrow Stringless and Stringless Black Valentine produced beans of superior appearance and good

quality, but they matured somewhat later and were not as prolific as either Bountiful or Giant Stringless.

Bean Fertilizer Tests: Four varieties of snap beans were planted across the fertilizer test plats during the fall season of 1936. In this test, 8-16-8 fertilizer is being compared with 8-16-0, 0-16-0, 8-0-0, and no treatment. Yield data have not been completed on these tests, but there is no visible effect on plant growth that could be attributed to the differential fertilizer treatments.

Carrot Variety Tests: Four comparatively new varieties of carrots are being grown for the purpose of comparing them with three varieties that are quite popular in this region. Nantes, Morse Bunching, and Red Core Chantenay are of superior quality but do not produce tonnage equal to that secured from plats of Imperator, Danvers, and Bagley carrots.

W. H. Friend.

Cabbage Variety Tests: During the 1935-1936 season, cabbage of the Midseason Market, Copenhagen Market, Glory of Enkhuizen, and Early Dwarf Flat Dutch varieties produced the most desirable heads. Stein's Flat Dutch and All Head produced fair yields, but the heads were too large to be desirable. Yields of Early Dwarf Flat Dutch were lower than those of other varieties, but the small, compact, green heads were of highly desirable type. In the 1936-1937 planting, twelve varieties are being studied to determine their relative adaptability. Ten strains of Enkhuizen Glory and nine strains of All Head are being used in connection with some source of seed studies which were started this year.

W. H. Friend, J. F. Wood.

Cabbage Fertilizer Tests: During the winter season of 1935-1936, cyanamid was the best source of nitrogen used, and 400 pounds per acre of this material gave yields slightly superior to those from plats receiving 600 pounds per acre of 6-18-0 fertilizer. The yields were approximately one ton in excess of those obtained from unfertilized plats. In the 1936-1937 tests, 8-16-8 fertilizer is being compared with 8-16-0 at two rates of application and with 0-16-0 and 8-0-0. Three sources of nitrogen, nitrate of soda, sulfate or ammonia, and cyanamid, are also being used in these tests.

Cabbage Seed Treatment: Red copper oxide dust applied to cabbage seed prior to planting caused no visible injury of any kind and reduced losses due to "damping off" (wire stem). Zinc oxide was not so effective, as the material does not adhere well to seed of this type.

Green Manuring Studies: Yields of cabbage from plats which grew a green manure crop of cowpeas during the summer seasons of 1934 and 1935 were no greater than those from a series of plats on land that grew cotton during this same period. Plats of beets, broccoli, collards, carrots, kale, lettuce, mustard, peas, spinach, and turnips are being

grown on these plats during the winter season of 1936-1937 to determine the effect of the green manuring treatment on yields of these crops.

W. H. Friend.

Potato Strain and Variety Tests: Eleven lots of Certified Bliss Triumph potatoes from North Dakota were compared with one check lot of Nebraska grown seed of the same variety, both on the Station farm and on the Nye plantation, a farm typical of the principal commercial potato producing section in the Lower Rio Grande Valley.

The best yields obtained on the Station farm ranged around 100 bushels per acre compared with 220 bushels per acre on the Nye plantation. The uncertified seed stock produced low yields in both locations, but Lot No. 8, which ranked first on the Nye plantation, ranked last on the Station farm. Lot No. 12, a stock produced in the eastern, or more humid portion, of North Dakota gave decidedly higher yields than did identically the same stock produced under dry farming conditions. In a supplemental test Texas grown and Certified seed of the Cobbler variety slightly outyielded Nebraska Certified potatoes of the Triumph variety.

Fall plantings of Houma, Chippewa, Katahadin, U.S.D.A. No. 45075, and Louisiana Triumph are being studied to determine the adaptability of these new varieties.

W. H. Friend, J. F. Wood.

Potato Seeding Tests: Seed stock saved from the spring potato crop were used in a study to determine the relative value of seed potatoes of three different sizes compared with cut seed. Growers maintain that cut seed do not give satisfactory results during the fall season, but this has not been the case in Station tests during the past three seasons.

Red copper oxide-clay dust (20-80) when applied to the cut seed has prevented decay of the seed pieces, about which growers have complained. Yields from No. 1 whole seed were no better than those from cut seed of No. 1 grade or from whole seed of second and third grade.

Spraying the cut seed pieces with an adhesive (starch solution), and then applying sulfur dust, also gave satisfactory results. A cement-sulfur treatment, applied to the cut seed, caused no injury and resulted in a perfect stand of plants.

Tomato Variety Tests: Bonny Best, Clarks Early, Stokesdale, Texas Special, and Break O'Day produced the highest yields and matured the greater part of their crop relatively early in the season. Yields of these early varieties ranged around 10 tons per acre. Globe varieties of the Rutgers, Scarlet Dawn, and Pritchard type produced yields ranging around 8 tons per acre, but were almost as late as Marglobe. Yields of Marglobe and Grothen's Globe ranged around 6 tons per acre.

Roy Humbert, a canning variety, produced an average yield of 11.5 tons per acre.

Tomato Fertilizer Tests: In the tomato fertilizer tests, plats receiving 0-20-0 fertilizer at the rate of 600 pounds per acre produced yields comparable with those obtained with an equal amount of 8-16-0 fertilizer, and 2.25 tons per acre greater than those produced by plats receiving no fertilizer treatment. A plat which had received 1000 pounds per acre of cyanamid produced yields approximately 3 tons per acre higher than those receiving comparable amounts of nitrate of soda or sulfate of ammonia. Fruits from these plats were larger in size and showed a decidedly higher percentage of severely puffed fruit than plats receiving no nitrogen or only moderate amounts. The plats receiving the nitrogen treatments were not replicated.

Tomato Irrigation Investigations: Tomato irrigation tests conducted during the fall season with plants of the Rutgers and Marglobe varieties showed that the application of irrigation water at two dates during the fruit formation period gave marked increases in yield. The irrigation treatment apparently had no effect in increasing the amount of severely puffed fruit except in the fruit harvested late in the season.

W. H. Friend.

Tomato Puff Investigations: An extensive study of tomato puffing during the 1936 season indicates that certain varieties, such as Bonny Best, Clark's Early, Texas Special, and June Pink, are much less likely to show a severe form of puffing than varieties such as Marglobe, Pritchard, Break O'Day, Rutgers, and others of the globe type.

Irrigation during the fruit forming period did not materially affect the percentage of severely puffed fruit except to cause a slight increase at the last of the season.

W. H. Friend, J. F. Wood.

Tomato Wrapping and Coloring Tests: Coloring tests conducted in connection with the variety and irrigation studies show that certain varieties develop a very poor, unattractive color when the fruits are harvested in an immature stage. This is especially true in the case of the Break O'Day variety. During the fall season, fruits of the Rutgers and Marglobe varieties, even of the larger sizes, required fully two weeks to reach full color. Thirty per cent of the fruits attained only half-color while another 10 per cent failed to show any red during a period of four weeks. This indicates that South Texas tomato growers should exercise caution, especially during the fall season, to avoid shipment of immature fruit which will not color properly and will be of inferior quality.

W. H. Friend.

Tomato Crosses: All of the crosses attempted this season failed due to continued rains during the blossoming season. Twenty individual plant selections were made from second generation plantings and a large quantity of seed saved for further trial. Eight plants were selected from the cross of Cooper's Special with June Pink, two plants from the cross of Cooper's Special with Gulf State Market, three plants from the cross

of Cooper's Special with Marglobe, two plants from the cross of Bonny Best with Cooper's Special, two plants from the cross of Marglobe with Pritchard, and three plants from the cross of Marglobe with Cooper's Special.

J. F. Wood.

Experiments With Agronomic Crops

Summer Legume Variety Tests. Guar gave the highest yield of air dried forage, (3.4 tons per acre), followed by Brabham cowpeas (2.1 tons per acre). Whip-Poor-Will cowpeas grown under comparable conditions produced 0.43 ton per acre. Sesbania produced 1.7 tons per acre, this relatively low yield being accounted for by severe nematode injury on one plat.

Winter Legume Variety Test: Hubam clover, Purple Vetch, and Subterranean clover ranked highest during the 1935-1936 season. Hubam clover yielded almost twice as much as the other two above mentioned varieties and more than six times as much as California Bur clover or Hairy Peruvian alfalfa. Artificial inoculation of the seeds did not materially affect yields except in the case of Austrian Winter peas.

Cotton Variety Tests: Of the six varieties of cotton grown this season, Delfos, No. 2323 and Delfos No. 531 produced the highest yields. Delfos No. 719 and Misdal No. 3 produced comparable yields. Yields of Mebane cotton were not equal to those of the best strains of Delfos and Misdal cottons.

The 1936 season was unfavorable for cotton up until June 1, but was quite favorable during the latter part of the season. Average yields ranged well above 600 pounds of lint per acre.

W. H. Friend.

Cotton Irrigation Test: Irrigation during a dry period in June had no appreciable effect on the yield of lint cotton from four plats of Misdal cotton.

Since the size of the plants was not affected by the irrigation treatment, it was evident that the water was applied too late in the season.

In previous years, irrigation just after the first bolls had formed has materially increased yields in a dry season.

Corn Variety Test: In the early planting, a local strain of Tuxpan corn outyielded Yellow Tuxpan by 20 bushels per acre. In a later test, this strain produced yields only slightly better than those obtained from the Angleton strain. Average yields ranged around 55 bushels per acre.

W. H. Friend.

Experiments With Ornamental Plants

Of the ornamental plants which have been added to the station collection during the past few years, *Holmskoeldia sanguinea* (Chinese Hat or Christmas Plant), *Citharexylum* (Zitherwood or Fiddlewood), *Manzanito* (Native

Crape Myrtle), and *Artobotrys* (Cinnamon Jasmine) deserve special mention because they are well adapted and of attractive appearance. Turk's Cap, Texas Wild Olive, Coral Tree, Cenisa, and Bush Morning Glory are being extensively used for highway plantings.

W. H. Friend.

Rust Mites and Red Spiders

The undescribed species of "red spider" reported in 1935 has been described by E. A. McGregor as *Anychus clarki*.

Comparisons were made of the effectiveness of sulphur when applied with and without a fish-tail applicator, and when the trees were dry and wet with dew. The fish-tail applicator is supposed to accomplish a more even distribution of the dust, but the results after using this apparatus do not appear any better than when the large nozzle is used. An application of sulphur dust with dew present is apparently as effective in controlling rust mites as lime-sulphur sprays even when fortified with wettable sulphur.

Population: Throughout the spring, rust mites were present, but in comparatively small numbers. The largest numbers occurred about the first of May. By the latter part of June they disappeared and none was found throughout the summer. In 1935 the heaviest population occurred in June, and there was only one month during the summer when mites were not present.

The infestation of red spiders, *Anychus clarki* McG., also was far below that found in 1935. A small infestation suddenly developed early in June, 1936, but soon disappeared. About the first of August another infestation began to develop. This reached its peak the last of August, but even then it was insignificant.

S. W. Clark, F. L. Thomas.

Biological Control

Parasites of scale insects on citrus collected in 1935 have been identified as *Aphytis chrysomphali* (Mercet.), *Aspidiotiphagus citrinus* (Craw.), *Prospaltella aurantii* (Howard), *Pseudohomolopada prima* Girault, *Thysanus* sp., (probably *flavopalliat*a (Ash.), *Aspidiotiphagus* sp., *Prospaltella* sp., and an undetermined species belonging to the family Myraridae.

No recoveries have been made of the yellow scale parasite, *Comperiella bifasciata*, which was liberated in October, 1934.

S. W. Clark.

A total of 3,750 specimens of the pink bollworm parasite, *Microbracon kirkpatricki*, was liberated in a cotton field heavily infested with boll weevil.

S. W. Clark, A. J. Chapman.

Truck Crop Insect Investigations

Two source materials containing rotenone were used in preliminary tests in control of cabbage worms. Cube' seemed slightly more effective than *Tephrosia virginiana* when diluted to the same rotenone content.

S. W. Clark.

As a result of the growing importance of the English pea crop, tests in controlling the pea aphid, *Macrosiphum pisi*, were undertaken. One application of nicotine dust, the same mixed with derris to contain one per cent rotenone, and a pyrethrum-sulphur mixture containing one-tenth of one per cent pyrethrins, gave good control in March.

S. W. Clark.

Heliothis obsoleta. Tomato fruit worms were controlled satisfactorily by means of a calcium arsenate-sulphur mixture, 1 to 2, in which approximately ten pounds of calcium arsenate per acre per application were used. The large amount used on that crop when obtaining satisfactory control confirms the work done by other Texas entomologists who conclude that at least 8 pounds of calcium arsenate per acre per application are necessary for control of this pest in cotton.

S. W. Clark.

Nysius ericae. Cube-sulphur containing .5 per cent rotenone appeared more satisfactory than a pyrethrum-sulphur mixture against the false chinch bug on turnips.

S. W. Clark.

Miscellaneous Insects

Dialeurodes citri and *D. citrifolii*. Infestations of these insects on citrus trees assumed alarming proportions this year. One application of oil spray gave fair control.

S. W. Clark.

For other insect investigations, see report of Division of Entomology.

Cotton Root Rot Investigations

Research work on the cotton root rot disease, *Phymatotrichum omnivorum*, as affecting fruit and truck crops in the Lower Rio Grande Valley, has been continued during the past year. This disease is known to attack a long list of both cultivated and non-cultivated plants excepting only the fibrous rooted plants. It is a limiting factor in the agricultural production of a number of crops that are otherwise adapted to the region. The work at this Station has embraced efforts to obtain information on the nature of the disease as well as on methods of control, and is a part of the general study of the disease under the Division of Plant Pathology and Physiology. The main lines of attack have been confined to testing the resistance of grape rootstocks, citrus rootstocks, cover crops, windbreak plants, and ornamentals. Extensive field inocu-

lations, soil, agar, and nutrient solution cultures in the laboratory, and a careful check of natural infection in the field, are means that have been employed in testing the resistance of plants. Some liquid culture work has been done using root juices in various combinations with a nutrient solution on which to grow the organism, in an effort to determine the factors responsible for resistance.

The writer cooperated in a study of the effect of sulphur on citrus for the control of diseases. A cooperative test on the control of Stem-End Rot in early citrus fruit was also conducted. Records were obtained on the control of late blight of potatoes where a grower had applied several different materials.

The prevalence of plant diseases during the year was recorded and growers were assisted with identification and control recommendations of various diseases.

Grape Rootstock Resistance Tests: The number of varieties of grapes which showed promise of being resistant was reduced from twelve in 1934 to six in 1936. The following varieties are included, ranking in resistance and desirability in the order named: Champanel, Dog Ridge, V. Champini, Black Spanish, V. Salonis (Cal. Var.), and Mustang.

Of this number, the Champanel appears to be the outstanding stock. The Dog Ridge also appears to be a very good stock. Reports from other locations in Texas show the high resistance of the Champanel rootstock to root rot under varying conditions. Both the Champanel and Dog Ridge rootstocks are reported by other workers as being highly resistant to nematode and phylloxera. They are, likewise, reported sufficiently congenial for commercial use.

The results of these root rot resistance tests date from 1927 to 1936, inclusive, and indicate the commercial possibilities of resistant rootstocks in establishing the grape industry in Texas, especially in the southern section or in any other root rot infected area.

Citrus Rootstock Resistance Tests: Field tests have been made on the available rootstocks similar to those made on grapes. Inoculations were made on 500 sour orange seedlings, 50 calamondins and 43 citrus hybrids, using the same plants that have been inoculated in previous seasons. No infection resulted, showing the high resistance of these varieties to root rot.

Resistance of Winter and Summer Legumes: The regular station planting of winter and summer cover crops was checked for the appearance of root rot following natural infection in the field. In addition, a few of the most promising varieties were planted for inoculation purposes. One or two susceptible varieties were also included in this planting for comparison. No infection occurred on any of the varieties of winter cover crop even in the inoculation test. The following varieties

were in the test: Austrian Winter Peas, Purple Vetch, Hubam Clover, *Melilotus indica*, Subterranean Clover, California Burr Clover, Hairy Peruvian Alfalfa, and White Biennial Sweet Clover. The inoculation test included Hubam Clover, Alfalfa, *Melilotus indica*, California Burr Clover, and Crimson Clover.

The planting of summer legumes included the following varieties, the per cent of root rot being indicated following each variety: Victor cowpea 25 per cent, Whippoorwill cowpea 31 per cent, Brabham cowpea 1 per cent, Bush Brabham cowpea 4 per cent, Guar 7 per cent, southern wilt 19 per cent, *Crotalaria intermedia* 0, *Sesbania* 0 with 11 per cent southern wilt. Nematode was severe on Victor and Whippoorwill cowpeas. The inoculation tests included the following varieties and per cent of root rot: *Sesbania* 0, *Crotalaria intermedia* 0, Black eye peas, 56 per cent, Brabham cowpeas 0, Victor cowpeas 10 per cent, Bush Brabham cowpeas 0, Pigeon peas 36 per cent, Chinese Red cowpeas 68 per cent. From the standpoint of resistance, the Brabham cowpeas is one of the most desirable summer cover crops for use in south Texas.

Resistance of Ornamentals to Root Rot: Fan palms, jasmine humile, and several other shade trees and shrubs were continued in this test. The palms were inoculated, after which the roots were examined. No infection resulted on any of the plants in the test.

The Occurrence of Root Rot on Vegetables: The most important and common vegetables were examined for root rot throughout the season. One hundred or more roots of each variety were examined and the results recorded. Carrots were the only vegetable on which any natural infection occurred. A planting of cabbage, broccoli, turnips, carrots, and beets was made for inoculation work. One hundred plants of each variety were inoculated. After a period of seventy-five days infection was found on the following plants when dug out and examined: Turnips 45 per cent, Carrots 34 per cent, and Beets 3 per cent. No infection was found on any of the other varieties in the test. In general, the loss caused on vegetables by *Phymatotrichum* root rot is negligible.

Tree Injections: Injections were continued on Citrus during the year. The following materials were used for their possible fungicidal effect in the control of root rot: Basic copper sulphate, iron sulphate, zinc sulphate, aluminum sulphate, ammonium nitrate, zinc oxide, mercuric chloride, ammonium hydroxide and water. A .01 per cent solution of Gentian violet was used in conjunction with each material in an attempt to determine the circulation in the branches and root system of the plants.

In soil cultures of freshly infected cotton roots in which the moisture (15 per cent) was supplied by the same dilutions of these chemicals, ammonium nitrate, ammonium hydroxide, mercuric chloride, and two dilutions of zinc sulphate showed an inhibiting effect on the growth of

the root rot organism. A good growth of mycelium was obtained in cultures in which water was used as the source of moisture. These chemicals were used at strengths of 2, 4, and 8 grams per 8 ounces of water, except the mercuric chloride which was used 1:500 and the ammonium hydroxide which was used 1:10 with water.

Zinc sulphate and sulphate of ammonia used around cotton plants at the rate of three ounces per plant, after which the plants were inoculated, appeared to inhibit root rot.

The Occurrence of Spore Spots: Records were obtained on the appearance, development, and maturity of 157 spore spots during the year. These records correspond fairly well with those on a large number of spots in 1927 and 1928. They show that spore spots appear and develop in a comparatively short period of time, usually two to four days. They change from the white cottony vegetative stage to the white covered stage, and later to the brown covered stage and finally to the brown powdery stage from which the spores are removed by either wind, rain, or insects.

Spore spots usually appear, according to these records, in September following the early fall rains, reach a peak of development in November, and continue through December. Their development is influenced by moisture, temperature, relative humidity, and possibly host relation and shade. The appearance of spore spots has been encouraged by sinking post holes in a planting of cotton where root rot occurred, but attempts at artificial reproduction have failed.

A Study of the Effect of Sulphur on Citrus: Applications of a ton per acre of crude ground sulphur broadcast around the trees has been made on six acres of Citrus at five different locations in the Valley on approximately the following dates: December 1933, July 1934, December 1934, and July 1935. There is a corresponding untreated acre for each acre that is treated in each location. Notes taken at six-month intervals show the condition of each individual tree in the test in respect to general size, amount of chlorosis, thickness of foliage, and amount of dead wood. Once each year the caliper of the trunk of the trees is recorded and soil samples collected for pH determination at one-, two-, and three-foot depths.

There has been a slight reduction of pH reading, from about 8.3 to about 7.3, in the surface foot of soil, and in some cases a slight reduction in the second foot. The greatest reduction was obtained where manure was applied around the trees in an attempt to keep them from dying. There has been an improvement in the general appearance of the treated trees at one location.

Sulphur spray and dust applications have been made on twenty blocks of 49 trees each. These tests have included sulphur dust, 200 and 300 mesh and different combinations, dry lime-sulphur, wettable

sulphur and with basic copper sulphate and Bordeaux mixture 4:4:50. sulphur alone, and in combination with one and two per cent Lime. The fruit from these plats was examined at the end of the season. There was no disease present in sufficient amount to draw any conclusions although traces of scab, septoria spot, gun spot, and melanose were found.

Stem-End Rot in Early Citrus Fruit: Stem-End rot caused serious losses during the early fall shipping season of 1935, and a cooperative test was conducted with several shipping organizations. Records revealed an average of 7.3 per cent decay causing a loss of 37.4 cents per box, or over one hundred dollars per car on twelve cars. Fruit was selected for these tests from early pruned trees, late pruned trees, and unpruned trees. Each of these lots was divided and half of the fruit dipped in a hot (117° F.) borax solution (5 per cent). These treatments were applied immediately after the fruit was picked and before it was placed in the coloring room. Lots of fruit were also included representing thick and thin rind, high and low solids, Bordeaux sprayed, basic copper sulphate, sprayed and unsprayed fruit. Physical and chemical analyses, including thickness of rind, brix, and acidity, were run on certain lots of these fruit, but judging from the limited samples run, these factors had no influence on decay.

Root Rot on Other Crops and Other Plant Diseases: The most common vegetables grown commercially in the section were periodically examined for root rot but very little natural infection was found. The prevalence of plant diseases was recorded during the year for a report to the Plant Disease Survey. This list included 61 hosts and 235 diseases during the past year. Many fruit, vegetable, and miscellaneous plant diseases were brought to the Station for identification and control recommendations.

W. J. Bach.

SUBSTATION NO. 16, IOWA PARK

Texas Substation No. 16 is located in the Wichita Irrigated Valley, 2½ miles southeast of Iowa Park, and 10 miles west of Wichita Falls, Wichita County, adjacent to the Fort Worth and Denver City Railway, and the paved State and U. S. National highways Nos. 370 and 70 from Wichita Falls to Amarillo. Latitude is 33 degrees and 55 minutes north; longitude 98 degrees and 39 minutes west; elevation 974 feet above sea level.

The average annual rainfall at this Substation is 30.14 inches for the 11-year period, 1926 to 1936, inclusive.

The Station comprises approximately 161 acres, of which 90 acres are devoted to crops under the irrigation ditch and 71 acres in river bottom and creek bottom pastures and waste land. The soil types on the station are of the Miller and Yahola series and are fairly typical of the

soils in the irrigated Wichita Valley. The Station was established in the fall of 1924 for the purpose of conducting agricultural research and experimental work with all crops grown in the Wichita Valley Irrigation project. Irrigation water is furnished the Station from Lake Kemp and Diversion Lake, through canals of the Wichita County Water Improvement District No. 2. A free and perpetual water right was given the Station by the Irrigation District at the time the Station was established. The work at this Station is directly concerned with the general improvement of agricultural crops and farming conditions in the Valley, and particularly stresses such phases of the work as vegetable growing, fruit production, alfalfa, cotton, small grains, and grain sorghum production, crop rotations, the study of proper uses and amounts of irrigation water required for cotton, grain sorghums, and alfalfa, as well as studies in root rot diseases of cotton and alfalfa. Studies are also conducted in other plant diseases and their control, as well as in the control of insect pests.

Cotton

Variety Test: Of 18 varieties and strains of cotton this year, Half and Half ranked first in yield with 408 pounds of lint per acre. Next in order of yield of lint per acre were Watson, 382 pounds; Kasch, 372 pounds; Ferguson 406, 370 pounds; D.P.L. No. 11, 343 pounds; Qualla, 339 pounds; Hurley Special, 331 pounds; New Boykin, 328 pounds; Mebane (A.D.), 325 pounds; and Mebane No. 141, 314 pounds. These 10 were the highest yielding varieties for 1936. Of the 18 varieties, Wild's Semi Wilt Resistant made the lowest yield of 219 pounds lint per acre.

In earliness, D.P.L. No. 11 ranked first with 71 per cent of the crop picked at 119 days from planting date. Next in order of earliness were Missdel No. 5 and Delfos 531-A, 70 per cent; Mars Rose, 64 per cent; Greer Wichita No. 540, 60 per cent; Wild's Semi Wilt Resistant, 57 per cent; Half and Half and Mebane No. 141, tied for eighth rank as to earliness, 51 per cent. Mebane (A.D.) ranked the lowest of all varieties as to earliness with only 38 per cent.

In lint percentages, Half and Half ranked first with 40.5 per cent. The next in order were Kasch with 38 per cent; Mebane (A.D.) with 37.3 per cent; Qualla with 37.2 per cent; Ferguson No. 406, 36.7 per cent; New Boykin, 36.3 per cent. Varieties with the lowest lint percentages were Stoneville No. 5, 31.2 per cent; Mars Rose, 30.8 per cent; and Wild's Semi Wilt Resistant, 23.7 per cent.

In length of lint, Wild's Semi Wilt Resistant produced the longest staple of 1 1-8 inches, while Half and Half produced the shortest staple of 13-16 inch. Next in order were Missdel No. 5 and Delfos No. 531-A with 1 3-32 inches, respectively; Greer Wichita No. 540, Acala (Rogers) and Stoneville No. 5 with 1 1-16 inches. Varieties producing staple of

15-16 to 1 inch were New Boykin, Kasch, Ferguson No. 406, Watson, Lone Star, Qualla, Mars Rose, Mebane No. 141, and Hurley Special.

In yields for the ten-year period, 1927-1936, Ferguson No. 406 ranked first with an average of 388 pounds lint per acre. Next in order were New Boykin, 363 pounds; Mebane (A.D.), 335 pounds; Acala (Rogers), 326 pounds; and Kasch, 318 pounds.

Spacing Tests: One variety, Mebane No. 141 from the Chillicothe Station, was used this year and spaced 3, 6, 9, 12, 18, 24, 30, 36, and 42 inches apart in the row. This year the 3-inch spacing ranked first in yield with 324 pounds lint per acre, followed by 6-inch spacing with 306 pounds. The next in order were the 9-inch spacing with 305 pounds; 12-inch spacing, 299 pounds; 18-inch spacing, 249 pounds; the 24-inch spacing, 234 pounds. The 42-inch spacing made the lowest yield of all plats with only 188 pounds lint per acre. The thicker spacings, ranging from 3 inches to 18 inches, were consistently earlier in maturity than the thinly spaced plats. Under irrigation the rate of spacing cotton does not seem to influence the length of lint to any significant degree.

For the 5-year period 1932-1936, the 36-inch and 12-inch spacing gave the highest average yields of 395 pounds of lint per acre, followed closely by the 9-inch spacing with 392 pounds. The next in order were the 18-inch spacing with 368 pounds, the 30-inch spacing with 352 pounds, and the 36-inch spacing with 339 pounds. The results of this test over this period of time indicate that a very wide variation can occur in cotton stands, under irrigation, without greatly affecting the total yield.

Dates of Planting Cotton: The variety used in this test was Greer Wichita No. 540, planted on seven different dates beginning April 28 and ending July 15. This year cotton planted April 28 ranked first with 220 pounds of lint per acre, followed by cotton planted May 1 with 212 pounds. Cotton planted as late as July 1 made only 35 pounds of lint per acre, while cotton planted July 15 produced no crop.

For the 6-year period 1931-1936, cotton planted between the dates of May 31 to June 3 ranked first with an average yield of 322 pounds of lint per acre, followed by cotton planted April 20 to April 28 with 279 pounds. Next in order came cotton planted May 1 to May 10 with 251 pounds, cotton planted May 15 to May 21 with 261 pounds, and cotton planted June 15 to June 20 with 197 pounds. From these data it is evident that a good crop of cotton can be obtained from plantings within the range of April 25 to June 1.

Amounts of Irrigation Water for Cotton: Plats receiving a total of 25.74 acre inches of irrigation water and natural rainfall made the highest yield of 246 pounds of lint per acre, followed closely by plats receiving 29.74 acre inches with a yield of 244 pounds. Next in order were plats which received 21.74 acre inches with 227 pounds and 17.74

acre inches with 182 pounds. Plats which received only 5.7 acre inches of natural rainfall, with no irrigation added, produced only 24 pounds of lint per acre. An addition of 20 acre inches of irrigation water produced practically ten times more cotton than dry land farming conditions.

For the 5-year period, 1932-1936, plats which received an average of 29.39 acre inches made the highest average of 348 pounds of lint per acre, followed closely by plats which received 32.19 acre inches with 340 pounds. Plats which received 26.59 acre inches produced 310 pounds of lint and indicate that the optimum water requirement for cotton in the Wichita Irrigated Valley ranges from 28 to 32 inches. For the same period, plats which received 17.39 acre inches produced only 209 pounds, while plats which received 14.19 acre inches made an average yield of only 168 pounds of lint per acre.

Grain Sorghum

Variety Tests: Eleven varieties made up the test this year. The season this year, on account of high temperatures and hot winds, was very unfavorable for growth and maturity of sorghums. This is the first year that Hegari, a former high yielding variety, failed to produce matured grain. Early maturing varieties such as Chiltex, Dwarf feterita, Hybrid No. 5, and Club kafir matured less than one-third of a normal crop. Later maturing varieties such as Hegari, Manko, Texas Blackhul kafir, Ajax, and Algeria were almost failures. Normally these later varieties have been fairly high producers.

Variety and Spacing Test: This test consisted of three varieties, Texas Blackhul kafir, Hegari, and Dwarf feterita, spaced 3, 6, 18, and 24 inches apart in a row with four replications. Dwarf feterita spaced 6 inches ranked first with 29.4 bushels of threshed grain per acre, followed by Dwarf feterita spaced 18 inches with 25.9 bushels. Next in order were Dwarf feterita spaced 3 inches with 25.6 bushels, Dwarf feterita spaced 12 inches with 22.4 bushels, Dwarf feterita spaced 24 inches with 19.9 bushels, and Hegari spaced 12 inches with 11.4 bushels. Texas blackhul kafir spaced 18 inches made the lowest yield of all varieties and spacings with only 4.2 bushels of threshed grain per acre.

For the 7-year period, 1929-1936, Feterita spaced 3 inches ranked first with an average yield of 52.57 bushels of threshed grain per acre, followed by Hegari spaced 3 inches with 47.57 bushels. Next in order were Feterita spaced 6 inches with 41.23 bushels, Hegari spaced 6 inches with 38.65 bushels, Blackhul kafir spaced 3 inches with 36.34 bushels, Feterita spaced 12 inches with 34 bushels, and Hegari spaced 12 inches with 33.90 bushels. For the same period Blackhul kafir spaced 24 inches made an average yield of only 23.53 bushels per acre.

Amounts of Irrigation Water for Grain Sorghums, (Hegari): Plats receiving a total of 47.77 acre inches of water, including natural rain-

fall and irrigation water applied, gave the highest yield of 26.08 bushels of threshed grain per acre, followed by plats receiving 42.77 acre inches with 23.03 bushels. Next in order were plats receiving 37.77 acre inches with 16.97 bushels, plats receiving 32.77 acre inches with 11.85 bushels, and plats receiving 31.77 acre inches with 8.14. Plats which received 17.77 acre inches of natural rainfall failed to make grain, and when four additional acre inches of irrigation water were applied no grain was produced. The failure to produce grain from these latter applications of water is due primarily to unfavorable seasonal conditions rather than a water shortage.

For the 5-year period, 1932-1936, plats which received an average of 38.02 acre inches of water ranked first in average grain production of 41.52 bushels of threshed grain per acre, followed by 34.62 acre inches with 40.34 bushels. Next in order were plats receiving 31.22 acre inches with 39.01 bushels, plats receiving 27.82 acre inches with 33.91 bushels, and plats receiving 24.62 acre inches with 29.55 bushels. For the same period the lowest average yield, (18.19 bushels of threshed grain) was made on plats which received only 18.42 acre inches of water.

Amounts of Irrigation Water for Alfalfa: This study was begun in 1935 and the results reported cover the 2-year period 1935-1936. Plats which received an average of 37.12 acre inches of water ranked first in yield with 3.82 tons of dry hay per acre, followed by plats receiving 49.12 acre inches with 3.80 tons. Next in order were plats receiving 33.12 acre inches with 3.68 tons, and plats receiving 41.12 acre inches with 3.56 tons. Plats which received 25.12 acre inches of natural rainfall made the lowest yield of all treatments with only 2.81 tons of dry hay per acre.

The alfalfa plats which received as much as 5 and 6 acre inches of irrigation water per application showed a heavy loss each year in stands due to scalding of the plants by excess water standing over the plats. Also heavy losses in stand occurred from excessive root rot infestation which killed the alfalfa out in large spots. This test indicates that alfalfa requires large amounts of water for normal growth and production and that irrigation water on the heavy soil types in this Valley should be made frequently at 10-day intervals with not more than 3 to 4 acre inches applied at each irrigation.

Small Grain

Wheat Variety Test: Five varieties of wheat made up the test this year with Quivira, a hard wheat, making the highest yield of 32.1 bushels of threshed grain per acre, followed very closely by Kanred with 32 bushels. Denton, a soft wheat, made the lowest yield of 28.2 bushels per acre. From these data it is evident that 1936 was more favorable to the production of hard wheat than of soft wheat.

Barley Variety Test: This test comprised five varieties of winter Barley sown in the fall of 1935. Finley ranked first with 61 bushels of threshed grain per acre, followed by Wisconsin Winter with 58.38 bushels. Tennessee Winter made the lowest yield of all varieties with 53.83 bushels. The year 1936 was very favorable for Barley production under irrigation.

Winter Oats Variety Test: Improved Texas Red Rust proof made the highest yield of 82.53 bushels of threshed grain per acre, followed by Nortex with 77.7 bushels. Frazier, an early variety, made the lowest yield of 62.75 bushels. The season was fairly favorable this year for small grain production.

Legumes

Winter Legume Variety Test: This test was winterkilled.

Spring Legume Variety Test: Nineteen varieties comprised this test consisting of cowpeas, soy beans, velvet beans, Lespedeza, Sesbania, Guar, Crotalaria, Beggarweed, and Mung beans. This season was very unfavorable for legumes due to an extremely long, hot, dry summer in which irrigation did not prove very effective. Extremely light yields of both forage and seed were obtained. Crotalaria and Lespedeza were complete failures. Guar and Sesbania led both in dry forage and seed production, followed closely by cowpeas. Soybeans failed to produce seed this year.

For the 6-year period, 1931-1936, Guar ranked first with an average yield of 1.68 tons of dry forage per acre, followed closely by Sesbania with 1.38 tons. Brabham cowpeas ranked third with 1.22 tons. For the same period O-Too-Tan soy beans made the lowest yield of all varieties with an average of only .47 ton of dry forage per acre.

In seed production for the same 6-year period, Guar ranked first with 703.06 pounds of threshed seed per acre, followed by Sesbania with 435.17 pounds. Next in order were Mung beans with 286.33 pounds, and Brabham cowpeas with 207.62 pounds. The lowest average yield was made by Bunch velvet beans with only 10 pounds of threshed seed per acre.

Crop Rotation Studies

Continuous cotton, Rotation No. 1 since 1932, ranked first with 280 pounds of lint per acre, followed by cotton on Rotation No. 9, a 4-year rotation with cotton following Hegari after alfalfa 2 years, with 264 pounds. The lowest yield of cotton was made with cotton following Hegari, Rotation No. 6, with only 203 pounds of lint per acre. On Rotation No. 11, where cotton follows 1-year alfalfa, heavy losses

occurred to both cotton and alfalfa due to root rot infestation. The practice of rotating cotton after alfalfa under irrigation is to be discouraged in the Wichita Irrigated Valley.

Continuous alfalfa since 1932 died out completely this year the last of August and early September due to root rot infestation. This crop seems to be more susceptible to root rot under irrigation than continuous cotton, and on root rot infested soil cannot be grown profitably for more than two years in succession.

The permanent cropping of winter oats since 1932 gave higher yields than any other system of rotation. C. H. McDowell.

Fruit Adaptability Studies

Peaches: Sudden variations and extremes in temperature during or immediately following the blooming period are the limiting factors in peach production in this section of the State. However, some varieties can stand more punishment along this line than others. Conditions involved are time of bloom, length of blooming period, and ability to withstand cold while in bloom or immediately following the blooming period.

A good crop of peaches was set in the spring of 1936, but hard freezes on April 2, 3, and 7, after blooming was completed, wiped out the entire crop. The minimum temperature on April 2 was 25 degrees and was accompanied by a strong north wind and low humidity. The minimum temperature on April 3 and 7 was 27 degrees and 24 degrees, respectively. While some varieties seldom produce a crop of fruit in this section, this is only the second failure in 8 years for some of the more consistent bearing varieties, such as Dr. Burton, Early Wheeler, Carman, Mamie Ross, Mayflower, Smith Indian, and Salway.

Plums: Plum varieties have a wider variation in bloom dates than peaches. It is not uncommon for some of the earlier blooming varieties of plums to be through blooming by the time the latest ones are starting. Those varieties that bloom late make a crop of fruit more often than those that bloom early. There is evidence, also, that some varieties can withstand more cold while in bloom, and after bloom, than others. The varieties Bilona, Compass Cherry, Mariana, Minco, Milton, Munson, Opata, and Sapa produced a few fruit this season, notwithstanding the April freezes after blooming was practically complete in all varieties.

Apricots: The Moorpark apricot failed to produce fruit this season due to the April freezes. A good set of fruit, which had attained the size of sparrow eggs, was completely destroyed by these freezes. It was the first complete failure for this variety in 5 successive seasons.

Nectarines: A number of varieties of nectarines tried on this Station have proved to be poor bearers and all failed to fruit this season due to the April freezes.

Grapes and Berries: The first condition for success of grapes in this valley is the ability to withstand root rot. Out of 20 varieties set out in 1931, only Champanel, Lukfata, Ladano, and Lomanto survive 100 per cent. Late freezes caused a heavy loss of fruit in all berries.

Vegetables

Adaptability Studies: The vegetable variety trials included 100 strains representing 25 different kinds of vegetables.

Burpee Stringless Green Pod and Bountiful continue to be the most productive varieties of bunch beans. The Pinto, although inferior in quality, produces 3 to 4 times as many green beans as Burpee Stringless Green Pod or Bountiful.

Beet varieties were damaged slightly this season by curly top, a disease spread by beet leaf hoppers.

Carrot varieties that were successfully grown this season were Chantenay, Danver's Half Long, Oxheart, and Tendersweet.

A number of varieties of chard, lettuce (curly), mustard, and spinach were successful for early greens this spring while plantings of Endive, chervil, chicory, and corn salad were failures due to poor germination.

In the cantaloupe trials, the Hale's Best and Perfecto strains continue to hold first rank in the commercial class.

Two varieties of cucumbers worthy of mention this season were Early Frame and Straight-8. Early Frame was the highest yielder in a class of 13 varieties. Straight-8 ranked third in yields and was outstanding for attractiveness and uniformity. In comparison, Early Fortune and Davis Perfect, two leading standard varieties, ranked second and fourth in yields, respectively.

Anaheim pepper, from home grown selected seed, showed more vigor but less uniformity of type than from first-class commercial seed.

Irish Cobbler potatoes outyielded Triumphs, but yields in both varieties were small.

Crystal Wax onion plants set in the field in March proved more successful than has been customary with earlier transplants.

Two varieties of okra, White Velvet and Dwarf Green, fruited successfully from July until frost.

The tomato crop was practically a complete failure this season due to adverse weather conditions. Continued drought and excessive temperatures prohibited the setting of fruit until September, and an early frost on October 27 killed the vines before fall-set fruit had time to mature.

Radishes were grown successfully in both spring and fall plantings.

Fall Trials: Curly lettuce and spinach, planted the first of September, have been ideal. Table beets were fair and radishes and turnips in the fall plantings have been first-class. These vegetables have proved to be much better adapted to fall conditions than to spring conditions.

Variety Descriptions (In cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture): The object of this test is to establish definite types of the more common vegetables through detailed descriptions and study of various strains collected from many different sources. Turnips and rutabagas are the vegetables being studied at this station. The work was begun in 1934 with more than 100 strains of turnips and 40 selections of rutabagas. This number has been reduced by elimination to 2 to 3 of the most typical strains of each major variety. Final eliminations will be made at the conclusion of this season's work. The major varieties included in this study are: White Milan, White Flat Dutch, Snowball, Purple Top Milan, Purple Top Strap Leaf, Purple Top White Globe, White Egg, Shogoin, Pomeranian, Seven Top, Golden Ball, Amber Globe, Purple Top Yellow Aberdeen, Cowhorn, and Bortfeldt. The major varieties of rutabagas included in these studies are: Ditmar's Bronze Top, Canadian Gem, Bangholm, Monarch, Sweet Perfection White, Sweet German, Neckless, American Purple Top, Corning Green Top, and Laurentian. It has been demonstrated that the fall season is a little too short for best results with rutabagas and some of the later maturing varieties of turnips, unless we have favorable weather conditions in August and can get them to growing early.

Onion Seed Production: Onion thrips caused severe damage to the onion seed production test this season. Only 138 pounds of re-cleaned seed were harvested per acre. This was estimated at about 35 per cent of a normal crop and the loss was attributed entirely to thrip damage. Winter hardiness was again demonstrated as the crop withstood a minimum temperature of 6 degrees on January 19, 30, 31, and February 8.

Asparagus Fertilizer Test: This test includes the following treatments: (1) barnyard manure, 20 tons per acre applied in the dormant season; (2) 4-8-4, 400 pounds per acre applied just after the cutting season; (3) the same as (2), plus 200 pounds of ammonium sulphate applied just as growth starts in the spring; and (4) a no-treatment check. Five years' results with these treatments show that barnyard manure has made an average of 50 per cent higher yield than the no-treatment check; whereas 4-8-4 alone has made only 10 per cent greater yield than the no-treatment check and the 4-8-4 plus ammonium sulphate has made a yield of 6 per cent less than the no-treatment check plats.

Green Manure as a Soil Improver: This test was started in 1934. The treatments are (1) Red Top cane plowed under in mid-summer; (2) cowpeas turned under in mid-summer; and (3) summer fallow check. Spinach as the indicator crop is planted in October and harvested in

January. Results thus far show a decided reduction in yields of spinach following the green manures as compared to the summer fallowed check plats. Furthermore, spinach following the Red Top cane makes very poor growth, and is yellow in color, and inferior in quality.

Shade Trees and Ornamentals

Trees native to this section of the State are proving most dependable for shade trees. These include pecan, hackberry, Western soapberry, mesquite, cottonwood, and sycamore. The cottonwood is short lived, but it grows rapidly and gives shade in just a few years. Hackberry and Western soapberry are very slow growing, but hardy. The sycamore is condemned because of its tendency to shed its leaves so early in the fall. The mesquite is hardy and attractive and, although it makes a poor shade, should have a place in the landscape plan. The Russian mulberry is used to advantage. Although susceptible to root rot, it has the ability to live on with the disease. *Chilopsis linearis* (Flowering Willow) is both hardy and attractive as a specimen plant.

Coniferous evergreens that have proved to be adapted to local conditions are: Red cedar, Pfitzer's juniper, Arizona cypress, and a large number of the arborvitae. In the broad leaf group of evergreens, a number of ligustrums, pyracanthas, jasmines, and nandina are proving desirable for specimen, group, and foundation plantings.

Of the deciduous shrubs tried here, *Vitex agnus castus* is proving indispensable to the farmstead planting, especially in locations where the ground is poor and it is difficult to get other things to grow. The common salt cedar is a hardy shrub suitable for screens, specimen, or hedges, and may be pruned so as to provide shade. The native coral berry is hardy and quite suitable for group or foundation plantings.

Some attention is being given to the use of native plants as ornamentals. The following are being used successfully on the station grounds at present: Shade trees, *Sapindus Drummondii*, *Celtis helleri* (Small), and *Prosopis juliaflora glandulosa*; shrubs, *Amorpha fruticosa*, *Condalia obtusifolia*, *Baccharis angustifolia* and *Symphoricarpos vulgaris*; perennials, *Liatris punctata*, *Tradescantia virginiana*; and annuals, *Gaillardia pulchella*, *Corydalis montana*, and *Lindheimera Texana*.

L. E. Brooks.

Root Rot Studies

Sorghum as a Root Rot Remover: A field known to be severely infested with cotton root rot fungus has been planted to Red Top cane for 3 years in succession and will continue to be planted to grass crops for a number of years to determine whether the fungus can be killed out by continuous cropping with a non-susceptible grass crop.

Cotton from X-Rayed Seed: In 1935, second year progeny from cotton seed that had been treated with X-ray showed approximately

90 per cent mortality from natural infection when grown in a field known to be severely infested with the cotton root rot fungus. Seed saved from the healthy plants were planted back in the same field in 1936. Good stands resulted and the field was clean cultivated and irrigated when necessary to supplement rainfall. In addition to the natural infestation of the root rot fungus in the soil, each individual plant was inoculated artificially. From the natural and artificial inoculation the loss of plants was very heavy. Only a few plants remained green at the end of the growing season. These were pulled and carefully examined for root rot infection. Approximately $1\frac{1}{2}$ per cent of the plants were apparently free from root rot. All seeds were saved from the healthy plants for further testing next season.

Grape Resistance Studies: The object of this experiment is to test the hardiness of various grape stocks which have shown marked resistance to root rot in some localities. The test was begun in 1934 and has involved a large number of grafted plants and rooted cuttings of the following stocks: Champanel, Lomanto, Lukfata, Black Spanish, Dogridge, La Pryor, Mustang, Cloeta, Candicans, Ladano, *Vitis Champani*, *V. cinerea*, and *V. rupestris*. Results thus far have shown that these stocks are not entirely immune from root rot, but that most of them are decidedly more tolerant of the disease than the grape stocks commonly used.

C. H. McDowell, L. E. Brooks.

SUBSTATION 19, WINTER HAVEN

Substation 19 is located in Dimmit County, between Carrizo Springs and Crystal City, in the center of a large area specializing in the production of winter vegetables with irrigation. Rainfall averages 21 inches annually but winters are mostly dry. The Substation is located on Webb fine sandy loam with about 100 acres in cultivation. Irrigation water is supplied by pumping with electric power.

The purpose of the substation is to study problems involved in the production of vegetables, fruits, and other crops, particularly under irrigation. During 1936 outstanding features were onion cultural experiments, fertilizer, and cultural experiments with tomatoes, vegetable variety studies, tomato and onion breeding, grape varieties and rootstocks, satsuma varieties and rootstocks, and strawberry breeding.

Low average temperatures in the winter gave enough dormancy for a good set of fruit on most of the deciduous fruits. Excellent yields of onions were obtained. High humidity and low temperatures adversely affected the fall tomato crop.

Fruits

Adaptability Studies: Texas Red, Helm, and Bledsoe apples set a crop of fruit this season although the trees are small. They began ripening about August 1.

Of seven apricot varieties, Early May was the earliest. Trevatt and Early May had the best eating quality. Best yields were obtained from Kerr, Toyahvale, and Tilton.

Mexicola avocado bloomed in the winter and the flowers were frozen. A Mexican seedling set a good crop of fruits which ripened the latter part of August.

Advance blackberries began to ripen April 4 and produced an excellent crop by May 8. Dallas blackberry produced fairly well this season with a ripening season from April 20 to May 13. Haupt was slightly later.

Rogers was by far the best variety of dewberry and ripened from April 4 to April 29.

Feijoas ripened a good crop of fruit.

As usual Green Ischia had the heaviest crop of figs but the fig crop in general was unusually light this season.

Grape varieties generally had good crops this season and fruiting records were obtained from 62 varieties. Heaviest yields (pounds per vine) were obtained from Tokay, 19.2; Black Prince, 16.6; Cornichon, 15.9; Alicante Bouschet, 15; Champanel, 13.2; Kurtelaska, 12.5; Grenache, 10; Lomanto, 9.4; Sultana, 7.6; Herbemont, 7.5. Yields given are from staked vines, except Lomanto and Champanel, which were trellised. The earliest varieties were Khalili, May 29-June 10; Black Corinth (seedless), May 10-June 19; Lomanto, June 1-15; Manito, June 10-17; Chasselas Neuschatel, June 10-22; Sultanina (Thompson Seedless) June 10-22; Chasselas Fontainebleau, June 10-26; Wapanuka, June 10-July 7; Sultana (seedless) June 12-24; Monukka (seedless) June 15-22; Alicante Bouschet, June 15-25; Sultanina Rosea (seedless) June 15-30. The best marketing varieties were Sultanina, Sultanina Rosea, and Chasselas Fontainebleau. Monukka is a good quality black seedless grape that is promising as an early table grape.

Strawberry guavas bore a few fruits.

Jujubes were badly damaged by insects. Best fruit yield was obtained from Lang.

A few fruits were borne on FPI 67975 nectarine, but nectarines generally failed to set fruit this year.

Forty-nine of the 60 peach varieties in the orchards set fruit this year, but of these only 14 gave satisfactory yields. No fruit was set at all on 11 varieties, and only a few fruits were produced on 21 varieties. Of these 21 varieties, the Saucer, or Peento, bloomed in midwinter and lost most of the crop through frost; the others probably failed to get enough dormancy. The best varieties from a market standpoint this year were Belle (July 7-20), Katherine (July 13-20), FPI 61302 (July 1-17). The early maturing varieties gave poor yields generally although

they began ripening in May. The heaviest yields were obtained from Luken's Honey, Pallas, Frank, Smith, Imperial, Waldo, and FPI 61302.

Pear varieties were mostly too young to set fruit. Douglas and Pine-apple set a little fruit.

Fruit yields were obtained from 18 of the 27 plum varieties planted. As in previous years the highest yield was obtained from Munson with an average of 139 pounds per tree. Good yields were also obtained from Jacob, Best's Hybrid, and Happiness. Fair yields were obtained from Burbank, Excelsior, Gonzales, and Methley. The earliest varieties in the order of ripening were Bruce, Methley, Munson, Beauty, Santa Rosa, Gonzales, Best's Hybrid, Excelsior, and Happiness. The most promising varieties from a commercial standpoint were Bruce and Methley, both red plums. The largest fruits were borne by Wickson and Becky Smith. For home use Best's Hybrid, Munson, and Burbank seemed the best this season.

De Antequera quince has not failed to bear a crop for four years. The fruit is useful only in canning and matures in October.

Citrus Rootstocks: Annual measurements are being taken on cions and stocks for buds set in 1932, 1933, and 1934. The stocks used were those available at the time.

The **1932 lot** consisted of Falsehybrid 48819, Kawano Wase, Owari, Silverhill, and Sueoka Wase satsumas on various varieties of citranges. Falsehybrid 48819 has made a better growth on Cunningham citrange than on Morton or Savage. Kawano Wase has developed more rapidly on Rustic and TS 15137 than on Cunningham and Savage. No significant differences were noted with Owari on either of 5 citrange varieties. Silverhill made the best growth on Cunningham and TS 15137, and buds on Savage have made the least growth. Sueoka Wase has grown best on Rustic. Yakushiji Wase grew better on Cunningham than Savage.

The **1933 buds** were oranges and tangerines on various citrange varieties, citrangequat, and trifoliata. Hamlin orange grew slightly better on TS 15137. There was little difference in top growth on trifoliata and Cunningham citrange but the cion has overgrown the stock on Cunningham. Joppa orange grew best on Rusk citrange, with slightly less growth on citrangequat. Growth was considerably less on trifoliata and the trees are very much smaller than on other stocks. Fruit was produced on trifoliata while none was produced on Rusk and only a few on citrangequat. Texas Navel made about equal top growth on Morton, Rusk, and TS 15137 citranges, slightly less on Cunningham, and least on trifoliata.

Clementine tangerine has grown slightly better on TS 15137 citrange than on trifoliata. On trifoliata the spread is greater than the height, while on TS 15137 the spread and height are equal.

Swatow tangerine has made about equal growth on trifoliata and Rusk citrange. On both stocks the height is considerably greater than the spread. On Rusk, the cion has overgrown the stock, while on trifoliata the stock has a greater diameter than the cion.

The **1934 buds** consisted of Silverhill, Owari, and Kawano Wase tested on trifoliata, sour orange, calamondin, Meyer lemon, citrangequat, Ichang lemon, Changsha orange, and various varieties of citranges. These have only had one year in the orchard and differences are not so noticeable. Kawano Wase has made best growth on Cunningham citrange, citrangequat, and sour orange. Owari has grown best on Rusk citrange, Calamondin, and trifoliata. Silverhill has grown best on trifoliata, Cunningham, and sour orange.

Meyer lemon grew better on trifoliata than on Meyer lemon roots.

Fruit was borne on Cunningham, Morton, Rusk, and 45019B citranges. A heavy crop was produced on Thomasville citrangequat, Kansu orange, and citradia. A few fruits were borne on Changsha orange.

Citrus Varieties: The first commercial crop of satsumas was produced this season. Heavy damage was caused by sap-suckers in the orchard. They drill holes in the fruit which then sours and rots. They preferred satsumas to other kinds of citrus. The earliest ripening varieties were Morita Wase, Hozaki Wase, Ishikawa Wase, and Shintani Wase.

A good crop of oranges was borne on a few trees of Louisiana Sweet and Purvis. A medium crop was set on Washington Navel. Louisiana Sweet is very seedy and of only fair quality but beautifully colored on the exterior. Purvis has good flavor and relatively few seeds.

Two Meyer lemon trees on trifoliata stock that were frozen to the ground in January 1934 bore 1513 fruits this year. Marsh Pink grapefruit bore a crop this year.

Meiwa and Nagami kumquats had heavy crops and were found useful in packing gift boxes of citrus. Some demand for fruits in making marmalade was noted.

Eustis limequat set a good crop. The plant is very tender and was even injured somewhat by 23°F. in January.

Date Varieties: Practically no fruit was produced this year. A few little bunches on Amir Haj seedlings indicate that they may be rain-resistant since they ripened on the palms during rainy weather without souring.

Grape Rootstocks: So far, considerable resistance to root rot has been shown by La Pryor (TS 20313), Lukfata, Champanel, Dogridge, and *Vitis cinerea* (TS 20312). Mortality of grafted stocks is, of course, complicated by cion congeniality, kind of union, etc. None of the above has died on their own roots.

Collections of 11 *berlandieri* selections, 10 *candicans*, 11 *monticola*, 6 *linceumii*, 2 *rotundifolia*, and 18 miscellaneous undetermined lots were made for rooting tests. Rooting percentages were mostly disappointing but a few *candicans* selections look promising.

In the grafting test, about 1700 grafts were made using cuttings of 33 stocks and mostly seedless varieties as cions. Sultanina (Thompson Seedless) gave mostly poor results; best take was obtained with La Pryor No. 2 (TS 22379), Elvicand, and TS 23039, a *candicans* selection. Sultanina Rosea also gave a poor take and had the best percentage on TS 23039. Black Corinth had 80 per cent take on Champanel with mostly failures on other stocks. Khalili had 90 per cent take on La Pryor, 60 per cent on Champanel, and 40 per cent on Dogridge. In general Champanel, Dogridge, and La Pryor gave best results, but indications in grafting tests so far are that no one stock can be best for all cions. The best stock for any certain variety will have to be worked out separately.

A grafting test on Mustang seedlings gave a very high per cent take with all combinations.

Strawberry Variety Adaptability and Breeding: Two hundred ninety selections from crosses in 1933 and 1934 were grown for comparison with commercial varieties. Named varieties of 38 kinds were also grown in this test.

Earliest varieties were Excelsior, Blakemore, Missionary, and Narcissa. In the crosses, 27 selections were earlier than Missionary, as indicated by yields before January 20. Selections from the Missionary x Redheart cross were exceptionally early.

Judged by fruit yields following frosts in January and February, the following varieties appear to have more frost resistance than Missionary: Excelsior, Fendalcino, Kalicene, Narcissa, and Thompson. One variety, Bederarena, completely covered its blooms and had no injury whatsoever.

Selections saved for 1937 trials included 27 high yielders, 24 average or medium, and 13 rated as poor yielders. In this group 33 were rated as early, 23 midseason, and 9 late. In the commercial varieties only 3 were classed as high yielders, 14 as medium, and 21 as poor. There were 7 early named varieties, 20 midseason, and 11 late. This indicates that some progress has been made in the breeding work.

Plant production records in the fall showed two selections with significantly higher plant yields than Missionary and 10 about the same or slightly better. In the named varieties, none produced as many plants as Carolina (Missionary), although Klondike, Aroma, Ettersburg 80, Kalicene, and Narcissa made a good showing.

At the end of two years' records on fruiting and plant production, 5 selections from the breeding work appear to have commercial possibili-

ties. Two are from a Missionary x Klondike cross, one from Blakemore x Klondike, one from Blakemore x "Banner," and one from Missionary x Redheart.

Strawberry Cultural Experiments: No significant differences in fruit yield were obtained from plants produced from mother plants that fruited in the spring as compared with plants produced from mother plants set in the spring and not allowed to fruit.

In the irrigation treatment irrigation at about every 1.75 and 2.25 inches of accumulated evaporation gave the best results until April 1 when records were discontinued. More frequent or less frequent irrigations resulted in reduced yields. E. Mortensen.

Storage of Satsuma Oranges in Moistureproof Cellophane: On December 6, 1935, in a small preliminary test, 15 freshly harvested satsuma oranges of the Owari variety were wrapped in moisture proof cellophane and stored on a laboratory shelf at room temperature alongside 15 unwrapped fruits. By January 15, 1936, the unwrapped fruits were noticeably losing their fresh appearance and by February 28 they had lost 27.8 per cent of their original weight, looked dry, and no longer peeled easily. In contrast to these, the wrapped oranges retained a fresh appearance, and on February 28 had lost only 12.3 per cent of their original weight, and their flavor had improved. Even in April the wrapped fruits still had a very good flavor, although through loss of moisture the rag was noticeable and detracted from the quality of the fruit as a whole. Several of the wrapped fruits decayed, but none of the unwrapped did. However, wrapping enabled the majority of the oranges to be kept in edible condition six to eight weeks longer than any unwrapped orange. L. R. Hawthorn.

Vegetables

Variety Descriptions (In cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture). The object in this work has been to obtain definite descriptions of ideal types of the more widely used vegetable varieties. Notes on the second year's trials of turnips and rutabagas were completed in the early spring of 1936. Thirty strains of turnips, representing 15 varieties, and 26 strains of rutabagas representing 13 varieties, were included in the tests. The trials indicate that turnips, as a whole, are better adapted than rutabagas. By the time the slow growing rutabagas have reached a stage when one might expect considerable root development, the weather is noticeably warming up, and conditions seem to become unfavorable. Practically all varieties of turnips grow well in the Winter Garden Region. Some of the better, more useful ones are: Purple Top, White Globe, and Shogoin. For earliness the Purple Top Milan and the White Milan should be grown. Golden Ball is an attractive globular turnip, with an especially rich external color of golden yellow. Among the rutabagas, Early

Neckless is easily the most useful and satisfactory variety. Under these far-south conditions it grows fairly rapidly and forms a large, rather smooth-surfaced root of excellent quality. It is yellow fleshed.

Adaptability Studies: This work has been reduced somewhat from the large scale on which it was being conducted several years back. Since the completion of the initial survey of most of the common varieties of vegetables, these studies have been re-organized so that within a period of three or four years the new or previously untried varieties are grown at least once. While it may not be always possible or feasible to study these varieties exhaustively, such tests as these are already throwing some light on the adaptability of some of the more prominent newer varieties.

During the past year the following varieties and strains of vegetables were included in the trials: asparagus, 10; dwarf lima beans, 17; dwarf snap beans, 4; cantaloupes, 59; cucumbers, 17; sweet corn, 29; and tomatoes, 46. This made a total of seven crops and 182 varieties.

For the first time since set out four years ago, all varieties of asparagus produced fairly well in the spring of 1936. Either or both of two factors may have contributed to this unusual occurrence. The winter of 1935-1936 was colder than usual and thus the asparagus may have been through a good dormant period. This factor alone may have been the cause. The asparagus was also irrigated more frequently and with larger amounts of water during the summer of 1935. While it is quite drought resistant, it was thought that perhaps under commercial conditions, advantage should not be taken of this fact. This heavier watering may also have contributed to the production of asparagus in 1936.

The McCrea Bush lima, a relatively new variety, proved to have rather small but well-filled pods containing rather attractive large beans. The variety was later than the well known Henderson, and was not a very good producer. Dreer's Bush had long pods containing 3 to 4 beans, and yielded fairly well. A variety by the name of Monstrous grew vigorously into the hot summer weather long after harvesting on other varieties was over, but although it flowered, no pods were set and the yield was nil.

A number of new inbred-crossed strains of various sweet corn varieties were grown for the first time in the 1936 trials and proved to be quite resistant to corn ear worm although parent varieties had previously proved to lack resistance. The higher yielding capacity of some of these sweet corns also gave them an advantage in a rating combining ear worm resistance and yield. From this point of view the better ones (all obtained from Dr. E. S. Haber, Iowa Agricultural Experiment Station) and listed in order of merit were: Iogold P39.145, Iogold 04.45, Iogold P51.145, Iogold 13.45, and Iogold 01.45. The White Evergreens did not show up quite so well. Sweet Snowflake and Sweet Dubois, two new

varieties from the Florida Experiment Station, showed excellent resistance to the corn ear worm, and also were rather productive. Unfortunately they were late, however, and in quality did not compare with the yellow kerneled crossed corns from the North.

Among the cucumbers Kirby Stay's Green again proved to be early and very productive. New varieties of longer and darker green cucumbers are more attractive and becoming more popular although they are usually not as productive. Promising varieties of this longer type grown in the Station's trials were: Straight 8, A. and C. Special, Ace, and Nicholson's Premium. The last mentioned was especially attractive, being uniform, smooth surfaced, and very dark green in color. All four of the cucumbers mentioned are dark green in exterior color, fairly long, $6\frac{1}{2}$ to $8\frac{1}{2}$ inches, with parallel sides. On the basis of one season's observations they could only be classified as fair yielders, but all are worthy of commercial trial.

In the cantaloupe test special attention was given this year to the numerous strains of Hale's Best which are now available. In all, 19 of the 56 samples of cantaloupes grown were strains of Hale's Best. As might be expected some of these strains are very similar in appearance and performance, and undoubtedly vary according to the sources from which they come. Naturally some seedsmen specialize in one, while other seedsmen specialize in another, and still other seedsmen give considerable attention to a series of strains. In this section Hale's Best Nos. 36 and 112 have probably been grown more than any. Both are well adapted.

In the Station's trials No. 112 was a trifle earlier, and the fruits somewhat smaller than No. 36. The new Mildew resistant strains of Hale's Best, such as Mildew Resistant Nos. 8, 50, Imperial 45, 50-15, etc., were not as a whole so attractive in appearance as the better strains of Hale's Best, nor did they show any better survival from the diseases experienced at Winter Haven. These strains show improvement in type each year and some are promising. Weaver's Special again proved attractive among the newer varieties. Jade Beauty, another white-skinned variety, had a pale greenish white flesh of very good quality. Other varieties of the same general type as Weaver's Special and Jade Beauty, and, like them, really worthy of trial were: White Knight, Mammoth Golden Globe, and Globo de Oro. Baby Persian, a small edition of the well known California cantaloupe—Persian, proved entirely unadapted for spring planting at least, being extremely late in ripening. Improved Perfecto and Pink Pearl, two cantaloupes similar in type, proved to be very much like Perfected Perfecto, grown and reported on in previous years. Like it they also had excellent appearance, shipping, and eating qualities, and were somewhat late in season.

Among new varieties of tomatoes, Grothen's Globe showed some promise. The fruit is globe in shape, red colored, with thick walls and a

good firm interior. It is more productive than Marglobe, but does not equal Bonny Best. Glovel, recently developed by the cooperation of the United States Department of Agriculture and the Florida Experiment Station, showed up well both in the spring and the fall, approaching Grothen's Globe in productivity. It also has an excellent globe shape, but unfortunately for the requirements of this section, is pink in color. It has a noticeable tendency to puff, too. Rutgers, another new and widely advertised variety, is too late and hence too low a yielder for this section. Stokesdale failed to be as promising in the fall as it was in the spring. Reported as being a single plant selection from Bonny Best, Stokesdale shows its relationship to that variety, but the fruits tend to be deeper. Neither Scarlet Dawn nor Penn State seem to have a place in the Winter Garden Region. Currie's Supreme, Texas Early, and Nystate all deserve further trial. Flori-globe does not have as much promise as any of these three, and Brown's Special, Kilgore's Special, and Fletcher's Special are entirely unadapted. Bonny Best (along with related varieties such as John Baer, Clarke's Early, etc.) continues to be the highest producer for this section, and Marglobe likewise continues to be a notoriously poor producer.

Spinach Irrigation: The tests along this line were brought to an untimely conclusion by the serious outbreak of the Curly Top disease reported upon elsewhere.

Onion Fertilizer: Early in 1936, Bulletin 524, "Fertilizer Experiments with Yellow Bermuda Onions in the Winter Garden Region of Texas" was published. This describes in full the results obtained and the conclusions drawn from the extensive series of tests reported upon more briefly in the Annual Report each year for the past several years. Conclusions were reached as to the value of each of three important nutrients, nitrogen, phosphoric acid, and potash, from several points of view, as well as the amounts of fertilizer which should be used, and the time and method of its application. Bulletin 524 also discusses the effects of fertilizer on earliness, grade, and keeping qualities as well as its relation to pink root, thrips, and freezes.

With the completion of this initial work, the fertilizer studies have been considerably reduced, and attention is now being centered on placement of the fertilizer and sources of phosphoric acid. The placement study has so far consisted of a simple comparison between broadcasting and placement. In the latter treatment the fertilizer was placed in a 4-inch band below the ridge into which the onions were later transplanted. With the proper machine a commercial grower could easily distribute the fertilizer and make the ridges all in the same operation. In this test a complete (6-12-6) fertilizer at the rate of 600 pounds per acre was used. An average of 323 bushels per acre of U. S. No. 1 onions was obtained from the plats in which the fertilizer was placed, against 234 bushels from the plats in which it was broadcast.

This was the second year in which an increase had been obtained from the "placed" treatment.

The source of phosphoric acid test was entirely new. In this test superphosphates analyzing 20, 32, and 45 per cent were compared with each other as well as with the fertilizer, 11-48-0. All were applied at rates equivalent to 360 pounds of 20 per cent superphosphate, so that the same amount of phosphoric acid was applied in each treatment. Of the straight superphosphates the 20 per cent resulted in the highest yield,—135 bushels of U. S. No. 1 onions, while the plats with 45 per cent gave 100 bushels, and the 32 per cent only 82 bushels. The 11-48-0 fertilizer resulted in 161 bushels. Final conclusions on this one year's test would be very unsafe, and it remains to be seen whether results in the future are similar.

Transplanting Practices with Onions: Every year for four years, on the basis of total yield, small plants (diameter at neck approximately 3-4 mm.) have yielded less than medium "pencil sized" (5-7 mm.), or large plants (7.5 to 10 mm. and over). With the exception of the 1934-1935 season, the large plants have yielded most, and when four seasons are averaged, they outyield the medium sized plants by over 100 bushels per acre. Unfortunately the value of these large yields has usually been reduced by large numbers of splits, doubles, and seed-stems, so that on the basis of the valuable commercial yield of U. S. No. 1 onions the medium sized plants have been the most dependable.

The clipping experiments were also conducted again during the past season. Definite conclusions cannot yet be made. In general there has been a tendency for plants in which the tops were clipped to yield less than those in which they were not. Clipping the roots has had less effect than clipping the tops.

Rates of Seeding: Because of the effect of plant size at transplanting time on the final yield (see above), tests have been made with various rates of seeding to determine what rate will give a good proportion of medium sized plants, and also a sufficient number of plants per acre. So far it has not proved practical to hand grade the plants for size. During the past season the following rates were tried (pounds of seed per acre): $4\frac{1}{2}$, $7\frac{1}{2}$, 10, 17, $26\frac{1}{2}$, and $38\frac{1}{2}$. The test indicated that a rate of seeding in the neighborhood of 17 pounds per acre, provided germination is high, will produce sufficient plants per acre to set about 10 acres with plants of fairly good size. Lower rates of seeding, while resulting in a higher proportion of plants of desirable size hardly produces enough plants per acre of seed bed to make the practice profitable.

Onion Irrigation: The frequency of irrigation tests were not conducted during the past season, as it is believed that sufficient data have been accumulated for the present on this particular phase of the subject.

Further tests on irrigation and handling at transplanting time indicated that while transferring the plants from seed bed to field as quickly

as possible, and watering immediately, may have been in previous tests the best practice, it was not for some reason the best this season. Final conclusions must therefore await further tests along this line.

Tomato Fertilizer: The fertilizer experiments started with tomatoes this past year replaced in part the onion fertilizer experiments which had been completed. The following fertilizer mixtures were used: 6-18-0 at rates per acre of 200, 400, and 600 pounds; and 0-18-0 at rates per acre of 400, 600, and 800 pounds. Three superphosphates analyzing 18, 32, and 45 per cent, respectively, as well as the fertilizer 11-48-0, were also tested in a source of phosphoric acid test, in which all were applied at a rate equivalent to 400 pounds per acre of 18 per cent superphosphate. The test was conducted on Webb fine sandy loam.

Taken as a whole the 6-18-0 treatments resulted in higher yields than the 0-18-0 treatments, indicating that nitrogen and phosphoric acid together are more desirable than phosphoric acid alone. Although the plats receiving 600 pounds of 6-18-0 outyielded those receiving only 200 pounds, the increase in yield was not significant. From a practical point of view the application of 200 pounds of 6-18-0 was the most profitable in this series; it resulted in 7988 pounds of marketable fruit per acre as compared with 2936 pounds from the unfertilized plats. Superphosphate alone, while not as effective, resulted in a significant increase in yield over no-fertilizer, the plats receiving 400 pounds of 0-18-0 yielding 6221 pounds of marketable fruit per acre. Larger applications did not appear profitable.

In the source of phosphoric acid test, the 11-48-0 treatment resulted in the highest yield, 8489 pounds of marketable fruit per acre. The treatments receiving the 18, 32, and 45 per cent superphosphates respectively produced yields of approximately 2000 pounds less per acre. There was no significant difference between them. This result differed somewhat from the results of 1935, in which 18 per cent superphosphate came out well ahead.

Tomato Irrigation: During the past season a frequency of irrigation test, very similar in type to that which the Station has had with onions for the past several years, was again made. Treatments were based on the following accumulations of evaporation (in inches): 1.75, 2.25, 2.75. Sufficient plats were started at 2.75 to allow some of them being changed to 1.75 inches (more frequent irrigation) when the fruit was beginning to form. Results for the 1935 season were none too definite, and unfortunately for this experiment, the 1936 season was too wet for a successful test of differential irrigation treatments. Therefore no conclusions can as yet be drawn.

Spacing Tests with Tomatoes: This work renewed the spacing studies reported upon in the 1932, 1933, and 1934 reports. Three spacings, 5x3 feet, 4x1½, and 3x3 feet were tried with the Bonny Best variety. The plats received 250 pounds per acre of 11-48-0 fertilizer. Although

the 3x3 feet spacing has considerably less plants per acre (4840) than the 4x1½ feet spacing (7260), the yield of marketable fruit from the plats planted 3x3 feet was 8862 pounds per acre compared with 7512 pounds for the 4x1½ spacing. The 5x3 feet spacing with the least plants per acre (2904) had the lowest yield, 5768 pounds per acre. With Bonny Best the 4x1½ feet spacing does not seem as profitable as it does with the Marglobe variety. The reason for this may be in the fact that under Winter Garden conditions Bonny Best inherently produces more fruit per plant, and because of this cannot stand the crowding that Marglobe can.

Spring Pruning of Tomatoes: A pruning experiment with tomatoes (Clark's Early) was attempted for the first time in the spring of 1936. Some tomatoes were left unpruned, others were pruned to one stem, and still others to two stems. The plants were pruned no more after the first tomatoes were almost mature. Unpruned plants were spaced 2 feet apart in 4-foot rows (5445 plants per acre), pruned plants were spaced 1½ feet apart in 3-foot rows (9680 plants per acre), and were not trained. Both pruned treatments produced mature fruit a week ahead of the unpruned one, and also yielded considerably more during the first four pickings. The one-stemmed plants excelled the 2-stemmed ones at first in yield, and for the early market were more profitable. Considering the entire harvest, however, the 2-stemmed plants excelled the 1-stemmed. The unpruned plants had the most marketable fruit per plant for the entire season, but there being considerably fewer plants per acre, this treatment gave the lowest yield on an acre basis. Further tests are planned.

Storage of Cucumbers in Cellophane: As in the previous years, freshly harvested cucumbers were wrapped in moisture-proof cellophane, or sprayed with paraffin, or left unwrapped, and then stored in a well ventilated office when room temperatures were running between 80° and 90°F. Some of those wrapped in the cellophane were disinfected with a chlorine solution before wrapping. Of these disinfected ones, some had the stems still attached; from others the stems were purposely removed. Unless they decayed first, fruits were removed from storage when they had lost 10 per cent of their original weight. All the moisture-proof cellophane treatments kept the fruits, on the average, well over 40 days, over twice as long as the approximate period during which they remained edible. Only in the cellophane-wrapped fruits did decay occur, and even this did not show up, on the average, under 40 days, although one disinfected fruit decayed in 12 days. The unwrapped fruits stayed in storage 5.9 days on an average, and the ones sprayed with paraffin remained 8.2 days. Moisture-proof cellophane was the most effective.

A number of cucumbers, both unwrapped and treated in various ways, were shipped to the Division of Rural Home Research for placement in

cold storage, and for use in other tests. A report of this work will be found elsewhere.

Breeding Vegetable Crops: Promising F_2 and F_4 selections of a cross originally made between Large Cherry and Bonny Best were planted for trial in the summer of 1936. Several of these showed considerable uniformity in plant and fruit characters, as well as in behavior, and practically all selections produced fruit abundantly during July and August when commercial varieties fail to act. Most of the fruits had no seed during this time, and while the fruit was smaller than in the cooler months, it did, in most selections, maintain size fairly well. Both mass and single plant selections were made, and seed obtained from fruit set in October and November.

A setback was suffered in the cantaloupe breeding work in which an attempt is being made to obtain a commercial melon resistant to sulphur burn. Considerable progress had been made in obtaining a cantaloupe having fair commercial possibilities, but resistance to sulphur burn had considerably decreased. It remains to be seen whether this obstacle can be overcome.

Considerable progress has been made towards a better strain of Yellow Bermuda onions. One second generation inbred strain has so far never thrown a double, split, seedstem, or an off-color bulb. Records on other strains indicate that selection towards or away from these characters does have an effect. Selection work has now also been begun towards a better Crystal Wax strain. Crosses have been made between Crystal Wax and White Persian, a thrips resistant onion. The work with onions is slow as it takes two years to secure a generation, but indications at present are that this may be a most valuable and useful undertaking.

L. R. Hawthorn.

Residual Effects of Green Manure Crops on Spinach: Cowpeas and Hegari plowed under in the summer and followed in the winter with a crop of spinach failed to show beneficial effects in 3 years' trials. In new land, spinach showed no residual benefits from either cowpeas or Hegari and gave a definite decrease in yield in the crop immediately following Hegari plowed under. Definite conclusions on the value of green manure for spinach could not be drawn from this experiment, and lack of finances prevented a thorough study of the problem.

E. Mortensen.

Ornamentals

Native Trees and Shrubs: During 1936, the best showing of native species was made by Apache plume (*Pallugia paradoxa*), cenisa (*Leucophyllum frutescens*), white brush (*Lippia ligustrina*), *Schaefferia cuneifolia*, and several native Lantanas. Palo blanco (*Celtis reticulata*) grew rapidly following transplanting and native elm (*Ulmus alata*) also made a good growth. *Arundo donax* has been found useful.

Introductions: Several mulberries are showing good adaptability. *Pyracanthas* and *Eucalyptus* are doing very well. The *Umbrella china* is doing well.

Iris Varieties: Most of the iris varieties were lost during the year from nematodes. E. Mortensen.

Field Crops

Corn Varieties: Best yield was obtained from Red June with 27.3 bushels per acre. Surcopper had 26.2, Reese 24.1, and the two new varieties, Yellow Surcopper and Golden June, had 21.2 and 20.9 bushels, respectively. Over a period of years Red June and Surcopper have been the high yielding varieties. The varieties were planted on May 7 this year.

Winter Legumes: Highest yield of air-dry forage was obtained from Austrian winter peas, Canada field peas, Hubam clover, and hairy vetch. Inoculation greatly improved the yields of alsike clover, crimson clover, black medic, and purple vetch. No significant response from inoculation was obtained from alfalfa, peas, or hubam clover.

Winter Grasses: Italian rye grass produced 4 tons of air dry forage per acre and rescue grass a little over 2 tons. Dallis grass was a failure due to poor germination.

Cowpea Inoculation: No significant response was obtained from inoculation with Chinese Red cowpeas which agrees with results in previous years.

Sugar Cane: Four "borer-resistant" varieties were obtained from the U. S. Department of Agriculture for testing. Best showing was made by Co. 290 but all four selections were badly infested by borers. POJ 36 M was found to have mosaic disease and was destroyed.

Cigar-leaf Tobacco: No crop was grown this year. Fermented tobacco was returned from Pennsylvania and cigars were made from some of the wrappers. The "burn" was not the best but was considerably better than that from the first year's crop. E. Mortensen.

Beet Leaf Hopper on Spinach

Early in January, 1936, an unusual spinach disease spread rapidly throughout the fields of Southwest Texas and particularly in the Winter Garden region. It caused severe losses to growers and a reduction in the railroad shipments. Leaf hoppers were quite abundant at the time. Entomologists at the Substation made an examination and collected fifteen species of leaf hoppers. Of 447 specimens which were taken by "sweeping" in seven spinach fields in the vicinity of Crystal City, 21 per cent were iden-

tified as *Eutettix tenellus*, the beet leafhopper, and a carrier of the virus which produces curly top disease in beets. Definite diagnosis was received later that the disease in the spinach fields of the Winter Garden was curly top. It was found that the beet leaf hopper occurred generally in the spinach fields and that the disease was abundant regardless of soil or other environmental conditions. No nymphs or young hoppers were collected in sweepings at fifty locations in Webb, Dimmit, Maverick, and Zavala Counties, and no adults were taken on native vegetation on the uplands. About the middle of May the beet leafhopper disappeared. While searching for locations of possible summer breeding grounds, the entomologist examined host plants in July at Eagle Pass, Del Rio, Sanderson, Fort Stockton, Ozona, Sonora, and Uvalde, but without finding any hoppers.

On September 24, 1936, the insects appeared again in the spinach fields at the time of the first northers, but in small numbers. Curly top disease in spinach was negligible and did not attract attention.

S. E. Jones, M. J. Janes, R. K. Fletcher.

Eggplant Yellows

Remarkable and satisfactory control was obtained by early and continued dusting with rotenone-sulphur (0.5-0.75 per cent) beginning with the seedlings. Growing the seedlings under cages was of some benefit. Plants from seedlings grown in the open, dusted with rotenone-sulphur were 3.1 per cent yellowed by November 30. Undusted plants from the same source were 92.9 per cent yellowed.

All evidence points to the possibility that certain insects are carriers of this disease. Effort will be made to determine what species are involved.

S. E. Jones, M. J. Janes.

Onion Thrips

Fewer onion thrips (*Thrips tabaci*) were present on the 1935-1936 crop than during the past several years. The infestation did not exceed 8.3 thrips per plant until after April 1. The peak for the season of 59.2 thrips per plant was reached April 22, at harvest time.

Tanglefoot screens or traps again were used to study the dispersal of onion thrips. Six screens were erected in or near a 12-acre onion field on the Substation. A one foot square area was examined daily in each cardinal direction on the screens. An average of 1518 onion thrips was removed from an acre of four square feet during the period November 20, 1935, to June 30, 1936. Of this number 1104 were caught during April and May at harvest time and while the ground was plowed.

In an examination of onion plants to determine the relative position of the thrips eggs a total of 513 eggs examined was found to be deposited promiscuously throughout the entire height of the plant. The range

in height was from one-half inch to nineteen inches above the onion bulb. The practice of "wringing" the tops at the time the onions are transplanted from the seed bed eliminates many of the eggs.

During the falls of 1935 and 1936, transfer of thrips infestation from the seed bed to the field consisted mainly of the transfer of eggs. Thrips eggs hatched in from 5 to 18 days, depending largely on weather conditions.

S. E. Jones, M. J. Janes.

Miscellaneous Insects

Heliothis obsoleta: Experiments on the control of the tomato fruitworm on fall tomatoes were conducted at Winter Haven during the seasons of 1935 and 1936. Calcium arsenate and rotenone dusts were applied to field plats. The arsenical dust was applied only early in the season while the tomato fruits were small, or about the size of a marble. Good control of the fruitworm was obtained. Rotenone (0.5-0.75 per cent) with sulphur and sulphur used alone did not give satisfactory control. During 1935 the peak of egg deposition was reached October 10. Egg parasites prevented hatching of practically all eggs after October 1.

S. E. Jones, M. J. Janes.

Phthia picta. A rotenone-sulphur dust (0.75 per cent) gave good control of this bug on tomatoes under field conditions. Two applications were required to protect a field which became infested July 27.

S. E. Jones.

Paratrioza cockerelli (Sulc.): On October 12 the potato psyllid was collected for the first time in Texas. It was taken in considerable numbers on tomatoes at Quemado, near Eagle Pass.

A survey was conducted to determine the occurrence of this psyllid in the Winter Garden. The species was found in every tomato field examined and at Laredo on the remains of frozen tomato plants. Nymphs and numerous eggs were present. In one case 58 eggs were counted on one plant, and 22 eggs were found on one leaf. A large percentage of the plants was affected with yellows.

M. J. Janes.

Phyllophaga cribrosa. Adult wingless May beetles destroyed thirty-five acres of spinach in a 640-acre field before they were controlled with poison bran mash. One hundred of the beetles were collected November 8, 1935, and placed in a cage over Bermuda grass. Twenty-nine were alive April 28, 1936, and two were alive June 30, 1936. Wingless May beetles are active in the afternoon on warm days throughout the year in Southwest Texas. They are most common in the spring. The observation that the adults may live for more than seven months may explain why the beetles have been seen during every month of the year.

S. E. Jones, M. J. Janes.

For other insect investigations, see report of Division of Entomology.

COOPERATION

Memoranda of agreement providing for cooperative research have been entered into or continued during the year with the following Bureaus of the United States Department of Agriculture:

Bureau of Agricultural Economics:

- (1) A study of agricultural adjustment in Texas;
- (2) Cooperative Cotton Fiber and Spinning Research (also with the Bureau of Plant Industry, and the Texas Engineering Experiment Station);
- (3) A Study of Farm Organization and Farm Practices in the High Plains Cotton Area of Texas.

Bureau of Agricultural Engineering:

- (1) Investigations on the Mechanical Application of Fertilizers for Cotton in Texas (also with the National Fertilizer Association and Joint Committee on Fertilizer Application);

Bureau of Animal Industry:

- (1) Investigations of the Loco Problem of Western Texas;
- (2) Beef-cattle husbandry investigations relating to the fattening of steers at different levels of feeding; (also with the Bureau of Plant Industry);
- (3) Beef-cattle feeding investigations to determine the quantity of carotene required for growing and fattening steers;
- (4) Beef-cattle feeding investigations relating to mineral-deficiency studies in range beef-cattle production.
- (5) A study of the inheritance of skin folds on Rambouillet sheep.

Bureau of Biological Survey:

- (1) Regional and state wildlife research (also with the Texas Extension Service, and the State Game, Fish and Oyster Commission).

Bureau of Chemistry and Soils:

- (1) Soil Surveys in the State of Texas;
- (2) Research in various citrus products and by-products (also with Weslaco and Mercedes chambers of commerce).

Bureau of Plant Industry:

- (1) The production, improvement, and diseases of cotton;
- (2) The production, improvement, and disease of cereal crops, particularly corn, wheat, oats, sorghum, and rice;
- (3) Investigations of plants possessing value as spray material, with special reference to devil's shoestring (*Cracca virginiana*);
- (4) Field testing of Satsuma orange varieties and hybrids and stock plants for them;
- (5) Study and description of American varieties of vegetable crop plants for the purpose of establishing variety type standards;
- (6) Investigations in the development of forage and soil improving crops adapted to Northern Texas and contiguous areas (at Substation No. 12, Chillicothe);
- (7) Experiments in the testing of dates, at Substation No. 15, Weslaco, and in Southwest Texas.

Bureau of Entomology and Plant Quarantine:

- (1) Investigations of insects and parasites affecting livestock;
- (2) Cotton insect investigations, including biology and control of pink bollworm and cotton bollworm.
- (3) Investigations on the resistance of honeybees to American foulbrood.

Soil Conservation Service:

- (1) Soil and water conservation within the State of Texas.

FINANCIAL STATEMENT

Texas Agricultural Experiment Station
College Station, Texas
September 15, 1936

Director A. B. Conner,
Texas Agricultural Experiment Station

Dear Director Conner:

There is submitted herewith the annual financial report of the Texas Agricultural Experiment Station for the fiscal year ended August 31, 1936.

In accordance with Section 2, Chapter 360, General Laws, Forty-fourth Legislature—Regular Session, all exhibits and schedules contained in this report have been prepared as nearly as practicable in conformity with the suggestions made by the National Committee on Standard Reports for Institutions of Higher Education.

Respectfully submitted,

M. P. HOLLEMAN, Chief Clerk.

Approved:
W. H. HOLZMANN,
Comptroller of Accounts.

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1936

A S S E T S

I.	CURRENT FUNDS		
A.	RESEARCH AND GENERAL		
	Cash.....	\$	101,645.54
	Balance in State Appropriations		
	(Schedule B-1a)		3,758.72
	Feed Control Tags		
	Inventory.....	\$	1,411.47
	C. O. D. Shipments.....		359.89
			1,771.36
	Supplies and Crops Inventories		
	Supplies.....	122,596.90	
	Crops.....	4,536.34	127,133.24
	Total Research and General.....		\$ 234,308.86
B.	AUXILIARY ENTERPRISES AND		
	ACTIVITIES.....		None
C.	CURRENT RESTRICTED FUNDS		
	Cash.....		1,842.39
	Total Current Restricted Funds.....		\$ 1,842.39
	TOTAL CURRENT FUNDS ASSETS.....		\$ 236,151.25
II.	LOAN FUNDS.....		None
III.	ENDOWMENT FUNDS.....		None
IV.	PLANT FUNDS		
	A. UNEXPENDED.....		None
	B. INVESTED IN PLANT		
	Physical Plant (Exhibit E).....	\$1,063,702.28	
	Total Invested in Plant.....		\$1,063,702.28
	TOTAL PLANT FUNDS ASSETS.....		\$1,063,702.28
V.	AGENCY FUNDS.....		None
	GRAND TOTAL ASSETS.....		\$1,299,853.53

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1936

LIABILITIES

I.	CURRENT FUNDS			
A.	RESEARCH AND GENERAL			
	Accounts Payable			
	Main College—Working Fund.....	\$	10,000.00	
	Main College—Feed Control			
	Tag Inventory and C. O. D.'s.....	1,771.36	\$	11,771.36
	Reserve for Supplies			
	Crops Inventories.....		127,133.24	
	Revolving Fund Balances (Schedule B-4)....		9,417.56	
	Current Balance			
	Appropriated for Special Purposes			
	Federal Hatch Fund Balance.....	1,227.21		
	Federal Adams Fund Balance.....	1,250.04		
	Federal Purnell Fund Balance.....	5,046.47		
	Federal Bankhead-Jones Fund			
	Balance.....	12,327.03		
	State Apprns. Bals.—Main Station.....	1,500.00		
	State Apprns. Bals.—Substations.....	85.00		
	Sales Fund Bals.—Main Station.....	25,004.23		
	Sales Fund Bals.—Substations.....	37,373.00		
	Total Appr. for Special Purposes		83,812.98	
	Reserve for Contracts and Orders		2,173.72	
	Total Research and General.....			\$ 234,308.86
B.	AUXILIARY ENTERPRISES AND			
	ACTIVITIES.....			None
C.	CURRENT RESTRICTED FUNDS			
	Fund Balances			
	(Per Exhibit B and Schedules B-3).....		1,842.39	
	Total Current Restricted Funds.....			\$ 1,842.39
	TOTAL CURRENT FUNDS LIABILITIES....			\$ 236,151.25
II.	LOAN FUNDS.....			None
III.	ENDOWMENT FUNDS.....			None
IV.	PLANT FUNDS			
	A. UNEXPENDED.....			None
	B. INVESTED IN PLANT (Exhibit E)			
	Net Investment in Plant	\$1,063,702.28		
	Total Invested in Plant.....		\$1,063,702.28	
	TOTAL PLANT FUNDS LIABILITIES.....			\$1,063,702.28
V.	AGENCY FUNDS.....			None
	GRAND TOTAL LIABILITIES.....			<u>\$1,299,853.53</u>

TEXAS AGRICULTURAL EXPERIMENT STATION

EXHIBIT B

Summary Statement of Current Funds

For the Year Ended August 31, 1936

BALANCES, September 1, 1935

Current Funds—Research and General			
Reserve for Outstanding Orders.....		\$	7,355.14
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$	1,861.10	
Federal—Adams Fund.....		1,457.00	
Federal—Purnell Fund.....		7,049.84	
Federal—Bankhead—Jones Fund.....		.00	
State Apprns.—Main Station.....		590.00	
State Apprns.—Substations.....		.00	
Sales Funds—Main Station.....		23,126.02	
Sales Funds—Substations.....		33,033.14	
			67,117.10
		\$	74,472.24

Current Restricted Funds

American Cyanamid Fellowship Fund.....		467.07	
Cuprocide Fund.....		15.00	
Texas Gulf Sulphur Fund.....		525.77	
Freeport Sulphur Co. Fellowship Fund.....		.00	
Special Fertilizer Fund.....		.00	
			1,007.84

TOTAL BALANCES, September 1, 1935.....

\$ 75,480.08

ADD:

Current Research and General Income			
(Schedule B-1).....		\$	532,418.45

DEDUCT:

Current Research and General			
Expenditures (Schedule B-2).....	519,479.44		
Unused 1934-35 Leg. Appro. reverted			
(Schedule B-1a).....	590.00	520,069.44	

Net Additions..... 12,349.01

BALANCES, August 31, 1936.....

\$ 87,829.09

Consisting of:

Current Funds—Research and General			
(Exhibit A, Section I-A)			
Reserve for Outstanding Orders.....		\$	2,173.72
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$	1,227.21	
Federal—Adams Fund.....		1,250.04	
Federal—Purnell Fund.....		5,046.47	
Federal—Bankhead—Jones Fund.....		12,327.03	
State Apprns.—Main Station.....		1,500.00	
State Apprns.—Substations.....		85.00	
Sales Funds—Main Station.....		24,804.23	
Sales Funds—Substations.....		37,573.00	
			83,812.98
		\$	85,986.70

Current Restricted Funds

American Cyanamid Fellowship Fund.....		.00	
Cuprocide Fund.....		290.45	
Texas Gulf Sulphur Fund.....		869.22	
Freeport Sulphur Co. Fellowship Fund.....		482.72	
Special Fertilizer Fund.....		200.00	
			1,842.39

Total, as Shown Above.....

\$ 87,829.09

SCHEDULE B-1**Statement of Current Income**

For the Year Ended August 31, 1936

	Total	Current General Funds	Current Restricted Funds
I. RESEARCH AND GENERAL			
1. Student Fees (None)			
2. Public Appropriations			
a. Federal			
Hatch Act (1881).....	\$ 15,000.00	\$ 15,000.00	
Adams Act (1906).....	15,000.00	15,000.00	
Purnell Act (1925).....	60,000.00	60,000.00	
Bankhead-Jones Act (1935).....	56,011.79	56,011.79	
Total Federal.....	\$ 146,011.79	\$ 146,011.79	
b. State Legislative Appropriations (Schedules B-1a and B-1b)	282,605.00	282,605.00	
Total Public Appropriations.....	\$ 428,616.79	\$ 428,616.79	
3. Endowment Income (None)			
4. Gifts and Grants (Schedule B-3).....	5,400.00		5,400.00
5. Sales and Services (Schedule B-1c)	97,731.59	97,731.59	
6. Other Sources			
Interest on Bank Balances.....	670.07	670.07	
Total Research and General (to Exhibit B).....	\$ 532,418.45	\$ 527,018.45	\$ 5,400.00

SCHEDULE B-1a**Summary of State Legislative Appropriations for Fiscal Year Ended August 31, 1936**

	Total	Main Station	Sub- Stations
Balances, September 1, 1935, from Appropriations for Previous Year.....	\$ 7,945.14	\$ 2,863.09	\$ 5,082.05
Add Appropriations for Current Year (Schedule B-1b)	282,605.00	143,378.00	139,227.00
Total Balances from Previous Year plus Appropriations for Current Year.....	\$ 290,550.14	\$ 146,241.09	\$ 144,309.05
Less Expenditures (Schedule B-2).....	286,201.42	143,098.22	143,103.20
Unexpended Balances.....	\$ 4,348.72	\$ 3,142.87	\$ 1,205.85
Less Reversions to State Treasury from Previous Year Balances (to Exhibit B).....	590.00	590.00	.00
Balance, August 31, 1936 (to Exhibit A).....	\$ 3,758.72	\$ 2,552.87	\$ 1,205.85

SCHEDULE B-1b

Statement of Current Income from State Legislative Appropriations
(General Revenue)

For the Year Ended August 31, 1936

(Pages 940 to 948, Gen. Laws, 44th Leg., Regular Session)

Main Station:

State Appro.

Number

U-1255—Salaries.....	\$ 47,244.00	
Less Amt. accounted for under Substations.....	6,138.00	\$ 41,106.00
U-1256—Administrative.....	3,000.00	
Less Amt. transferred to State Auditor's Dept.....	225.00	2,775.00
U-1257—Veterinary Science.....		2,370.00
U-1258—Horticulture.....		3,350.00
U-1259—Range Animal Husbandry.....		5,690.00
U-1260—Entomology (Including Foul Brood).....		9,604.00
U-1261—Apiculture.....		5,938.00
U-1262—Agronomy.....		3,180.00
U-1263—Main Station Farm.....		4,340.00
U-1264—Plant Pathology.....		1,830.00
U-1265—Soil Survey.....		7,847.00
U-1266—Farm and Ranch Economics.....		4,940.00
U-1267—Publications.....		3,000.00
U-1268—Botany.....		200.00
U-1269—Cotton Root Rot Investigations.....		26,128.00
U-1270—Cotton Insect Investigations.....		12,380.00
U-1271—Loco Weed Research.....		5,700.00
U-1271½—Garlic Smut Research (Emergency) (Gen. Laws, 44th Leg. 2nd C. S.).....		3,000.00
Total Main Station.....		\$ 143,378.00

Substations:

U-1255—Salaries (See Main Station).....	6,138.00
U-1272—No. 1—Beeville.....	4,088.00
U-1273—No. 2—Tyler.....	11,082.00
U-1274—No. 3—Angleton and Plant Lice Laboratory.....	11,188.00
U-1275—No. 4—Beaumont.....	5,788.00
U-1276—No. 5—Temple.....	3,750.00
U-1277—No. 6—Denton.....	4,940.00
U-1278—No. 7—Spur.....	4,695.00
U-1279—No. 8—Lubbock.....	6,445.00
U-1280—No. 9—Balmorhea.....	4,088.00
U-1281—No. 10—College Station (Feeding and Breeding).....	5,475.00
U-1282—Division of Dairy Husbandry.....	2,255.00
U-1283—Division of Swine Husbandry.....	3,855.00
U-1284—Division of Poultry Husbandry.....	3,440.00
U-1285—No. 11—Nacogdoches.....	21,288.00
U-1286—No. 12—Chillicothe.....	4,040.00
U-1287—No. 14—Sonora.....	11,538.00
U-1288—No. 15—Weslaco (Lower Rio Grande).....	9,149.00
U-1289—No. 16—Iowa Park (Wichita Valley).....	7,990.00
U-1290—No. 19—Winter Haven.....	7,995.00

Total Substations.....	\$ 139,227.00
Total State Legislative Appropriations.....	\$ 282,605.00

SCHEDULE B-1c

Statement of Current Income from Sales and Services
For the Year Ended August 31, 1936

Main Station:	
Administrative.....	\$ 186.46
Veterinary Science.....	1,812.09
Horticulture.....	41.70
Entomology.....	331.50
Apiculture.....	41.00
Agronomy.....	623.46
Main Station Farm.....	2,468.33
Plant Pathology.....	94.00
Loco Weed Research.....	126.00
Chemical Analysis.....	17,750.00
Photographic Laboratory.....	2,506.92
Big Spring Cattle Feeding.....	636.69
Rural Home Research.....	123.85
Total Main Station.....	\$ 26,742.00
Substations:	
No. 1 —Beeville.....	2,868.29
No. 2 —Tyler.....	2,831.04
East Texas Soil Erosion.....	475.26
No. 3 —Angleton.....	1,710.97
Plant Lice Laboratory.....	189.20
No. 4 —Beaumont.....	657.77
No. 5 —Temple.....	530.68
Temple Soil Erosion.....	1,555.41
No. 6 —Denton.....	2,487.85
No. 7 —Spur.....	6,432.25
No. 8 —Lubbock.....	1,270.55
No. 9 —Balmorhea.....	1,793.89
No. 10—College Station (Feeding and Breeding).....	900.60
Division of Dairy Husbandry.....	11,981.54
Division of Swine Husbandry.....	6,772.19
Division of Poultry Husbandry.....	3,654.51
No. 11—Nacogdoches.....	449.51
No. 12—Chillicothe.....	1,695.43
No. 14—Sonora.....	13,985.10
No. 15—Weslaco (Lower Rio Grande).....	4,377.65
No. 16—Iowa Park (Wichita Valley).....	1,689.39
No. 19—Winter Haven.....	2,680.51
Total Substations.....	\$ 70,989.59
Total Sales and Services.....	\$ 97,731.59

SCHEDULE B-2

Statement of Current Expenditures

For the Year Ended August 31, 1936

RESEARCH AND GENERAL	FUND DISTRIBUTION				OBJECT CLASSIFICATION				
	CURRENT GENERAL FUNDS			Current Re- stricted Funds	Grand Total	Salaries and Wages	Other Operat- ing Expense	Equip- ment	Buildings and other Improve- ments
	Federal Funds	State Apprs.	Sales Funds						
Main Station	\$ 10,707.13	\$ 18,650.48	\$ 1,367.62	\$ 30,815.23	\$ 30,815.23	\$ 25,710.70	\$ 4,640.32	\$ 464.21	
Administrative.....	3,906.24	5,520.00	1,197.21	11,363.45	11,363.45	8,170.55	2,002.09	1,190.81	
Veterinary Science.....	4,622.03	6,410.00	174.53	11,056.56	11,056.56	8,139.24	983.73	1,201.05	\$ 732.54
Horticulture.....	13,453.19	11,053.52	395.72	24,902.43	24,902.43	19,842.54	3,775.88	4,284.01	
Range Animal Husbandry.....	6,194.98	24,838.58	258.24	31,291.80	32,387.13	27,507.36	4,717.40	1,623.37	
Entomology.....		5,962.08	57.43	6,019.51	6,019.51	5,352.81	465.30	1.40	
Apiculture.....		9,215.00	488.42	28,908.59	29,375.66	22,984.40	1,945.70	445.40	4,000.46
Agronomy.....	19,205.17	4,340.00	2,536.63	6,876.63	6,876.63	5,742.36	1,023.27	111.00	
Main Station Farm.....	3,929.98	4,830.65	16.18	8,776.81	11,779.86	8,117.05	2,561.43	882.75	218.63
Plant Pathology.....		7,720.25	262.30	7,982.55	7,982.55	6,743.18	744.05	491.50	
Soil Survey.....	32,425.54	6,734.03	30.14	39,189.71	39,189.71	33,753.18	2,942.57	2,513.96	
Farm & Ranch Economics.....	499.99	4,987.00		5,486.99	5,486.99	2,486.99	2,759.04	240.96	
Publications.....	1,329.00	1,271.00		2,600.00	2,600.00	2,400.00	200.00		
Botany.....		25,974.02		25,974.02	25,974.02	23,318.00	2,499.94	156.08	
Cotton Root Rot Research.....		5,591.61	9.78	5,601.39	5,601.39	5,392.47	208.92		
Loco Weed Research.....	14,622.00		15,900.61	30,522.61	30,522.61	24,676.37	3,506.60	2,339.64	
Chemistry.....			1,987.52	1,987.52	1,987.52	907.00	894.77	185.75	
Photographic Laboratory.....	14,529.24		271.53	14,800.77	14,800.77	12,423.59	1,221.71	1,155.47	
Rural Home Research.....	6,528.50			6,528.50	6,528.50	5,743.05	622.18	163.27	
Agricultural Engineering.....									
Total Main Station.....	\$132,052.99	\$143,098.22	\$25,533.86	\$300,685.07	\$305,250.52	\$246,594.36	\$37,714.90	\$15,989.63	\$ 4,951.63
Substations									
No. 1—Beeville.....	\$ 4,088.00	\$ 2,716.52	\$ 6,804.52	\$ 6,804.52	\$ 6,804.52	\$ 4,514.11	\$ 2,201.31	\$ 89.10	
No. 2—Tyler.....	11,106.03	1,249.56	12,355.59	12,355.59	12,355.59	8,582.17	2,670.49	1,102.93	
No. 3—Angleton.....	7,090.50	2,151.64	9,242.14	9,242.14	9,242.14	6,143.25	1,709.74	617.99	\$ 771.16
Plant Life Laboratory.....	4,069.41	160.40	4,229.81	4,229.81	4,229.81	3,352.50	820.91	56.40	
No. 4—Beaumont.....	5,783.43	561.68	6,325.11	6,325.11	6,325.11	4,852.14	1,180.38	292.59	
No. 5—Temple.....	3,694.24	1,946.65	5,720.89	5,720.89	5,720.89	4,128.05	1,218.00	674.84	
No. 6—Denton.....	4,940.00	2,140.42	7,080.42	7,080.42	7,080.42	5,410.26	1,608.72	61.44	
No. 7—Spur.....	4,695.00	5,808.28	10,503.28	10,503.28	10,503.28	7,643.20	4,426.46	433.62	
No. 8—Lubbock.....	11,073.04	2,849.03	13,922.07	13,922.07	13,922.07	7,956.21	2,251.70	964.11	
No. 9—Balmorhea.....	4,088.00	3,185.34	7,273.34	7,273.34	7,273.34	4,855.55	2,401.49	16.00	
No. 10—College Sta.(F&B)	5,475.00	1,011.09	6,486.09	6,486.09	6,486.09	4,206.58	1,926.72	254.38	98.61

[illegible]

* Includes \$3,000.00 for purchase of land.

Analysis by Sources of Funds and Expense Classes

	DISTRIBUTION BY DIVISIONS		DISTRIBUTION BY EXPENSE CLASSES				
	Main Station	Sub-Stations	Total	Salaries and Wages	Other Operating Expense	Equipment	Buildings and Other Improvements
Research and General Expenditures							
Current General Funds							
Federal Funds							
Hatch Fund.....	\$ 14,803.90	\$ 829.99	\$ 15,633.89	\$ 15,027.96	\$ 585.53	\$ 20.40	
Adams Fund.....	15,206.96		15,206.96	15,189.46	17.50		
Purnell Fund.....	62,003.37		62,003.37	54,500.30	5,100.70	2,402.37	
Bankhead-Jones Fund.....	40,038.76	3,646.00	43,684.76	24,967.19	4,199.67	10,006.77	4,511.13
Total Federal Funds.....	\$ 132,052.99	\$ 4,475.99	\$ 136,528.98	\$ 109,684.91	\$ 9,903.40	\$ 12,429.54	\$ 4,511.13
State Appropriations.....	\$ 143,098.22	\$ 143,103.20	\$ 286,201.42	\$ 226,484.56	\$ 43,627.46	\$ 8,837.50	\$ 7,251.90
Sales Funds.....	25,533.86	66,649.73	92,183.59	44,423.62	38,532.68	5,698.28	3,529.01
Total Current General Funds.....	\$ 300,685.07	\$ 214,228.92	\$ 514,913.99	\$ 380,593.09	\$ 92,063.54	\$ 26,965.32	\$ 15,292.04
Current Restricted Funds (Schedule B-3).....	4,565.45		4,565.45	2,527.12	1,911.33	127.00	
Total Research and General Expenditures.....	\$ 305,250.52	\$ 214,228.92	\$ 519,479.44	\$ 383,120.21	\$ 93,974.87	\$ 27,092.32	\$ 15,292.04
							*Includes \$3,000.00 for purchase of land.

*Includes \$3,000.00 for purchase of land.

SCHEDULE B-2a**Statement of Federal Hatch Fund**

For the State Fiscal Year Ended August 31, 1936

Balance, September 1, 1935.....	\$ 1,861.10	
Received from United States Treasurer.....	15,000.00	
Balance, September 1, 1935, plus additions.....		\$ 16,861.10
Less: Expenditures:		
Personal Services.....	15,027.96	
Supplies and Materials.....	5.00	
Communication Service.....	.66	
Travel Expenses.....	497.70	
Contingent Expenses.....	9.36	
Equipment.....	93.21	
Total Expenditures.....		\$ 15,633.89
Balance, August 31, 1936.....		\$ 1,227.21

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2b**Statement of Federal Adams Fund**

For the State Fiscal Year Ended August 31, 1936

Balance, September 1, 1935.....	\$ 1,457.00	
Received from United States Treasurer.....	15,000.00	
Balance, September 1, 1935, plus additions.....		\$ 16,457.00
Less: Expenditures:		
Personal Service.....	15,189.46	
Communication Services.....	1.66	
Transportation of Things.....	13.85	
Heat, Light, Water and Power.....	1.99	
Total Expenditures.....		\$ 15,206.96
Balance, August 31, 1936.....		\$ 1,250.04

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2c**Statement of Federal Purnell Fund**

For the State Fiscal Year Ended August 31, 1936

Balance, September 1, 1935.....	\$	7,049.84	
Received from United States Treasurer.....		60,000.00	
Balance, September 1, 1935, plus additions.....	\$		67,049.84
Less: Expenditures:			
Personal Services.....		54,500.30	
Supplies and Materials.....		2,268.02	
Communication Service.....		240.59	
Travel Expenses.....		1,038.25	
Transportation of Things.....		75.86	
Heat, Light, Water and Power.....		336.62	
Contingent Expense.....		12.68	
Equipment.....		3,225.71	
Buildings and Land.....		305.34	
Total Expenditures.....	\$		62,003.37
Balance, August 31, 1936.....	\$		5,046.47

NOTE: Income and Expenditures are included in Schedules B-1 and B-2.

SCHEDULE B-2d**Statement of Federal Bankhead-Jones Fund**

For the State Fiscal Year Ended August 31, 1936

Balance, September 1, 1935.....	\$	.00	
Received from United States Treasurer.....		56,011.79	
Balance, September 1, 1935, plus additions.....	\$		56,011.79
Less: Expenditures:			
Personal Services.....		24,967.19	
Supplies and Materials.....		2,401.64	
Communication Service.....		82.29	
Travel Expense.....		1,264.72	
Transportation of Things.....		42.49	
Heat, Light, Water and Power.....		19.60	
Contingent Expenses.....		5.00	
Equipment.....		10,057.21	
Buildings and Land.....		4,844.62	
Total Expenditures.....	\$		43,684.76
Balance, August 31, 1936.....	\$		12,327.03

NOTE: Income and Expenditures are included in Schedules B-1 and B-2.

SCHEDULE B-3

Statement of Current Restricted Funds
For the Year Ended August 31, 1936

	INCOME		EXPENDITURES				Balance Aug. 31, 1936 (Exh. A: B)
	Balance Sept. 1, 1935	Gifts (Sch. B-1)	Total Balance and Additions	Salaries and Wages	Other Operating Expense	Equip- ment	Total
FOR RESEARCH AND GENERAL PURPOSES							
American Cyanamid Fellowship.....	\$ 467.07		\$ 467.07	\$ 354.72	\$ 112.35	\$ 82.36	\$ 467.07
Texas Gulf Sulphur Fund.....	525.77	3,100.00	3,625.77	1,524.38	1,149.81	2,756.55	869.22
Cuprocide Fund.....	15.00	1,000.00	1,015.00	376.02	309.89	38.64	290.45
Freeport Sulphur Co. Fellowship.....		1,100.00	1,100.00	272.00	339.28	6.00	724.55
Special Fertilizer Fund.....		200.00	200.00				482.72
Total Research and General.....	\$ 1,007.84	\$ 5,400.00	\$ 6,407.84	\$ 2,527.12	\$ 1,911.33	\$ 127.00	\$ 4,565.45
							\$ 1,842.39

SCHEDULE B-4

Transactions of Revolving Funds
For the Year Ended August 31, 1936

	CREDITS		EXPENDITURES				Credit Balance Aug. 31, 1936 (Exh. A)
	Credit Balance Sept. 1, 1935	Sales	Total Balance and Additions	Salaries and Wages	Other Operating Expense	Equip- ment	Total
FOR ORGANIZED RESEARCH							
Wool Scouring Plant.....	\$ 425.01	\$ 5,656.92	\$ 6,081.93		\$ 5,568.22	2.00	\$ 5,570.22
Cattle Feeding Revolving Fund.....	11,777.43	8,182.58	19,960.01			11,054.16	\$ 511.71
Total Organized Research.....	\$ 12,202.44	\$ 13,839.50	\$ 26,041.94		\$ 5,568.22	\$ 11,056.16	\$ 8,905.85
							\$ 16,624.38
							\$ 9,417.56

EXHIBIT E

Summary Statement of Investment in Plant

At August 31, 1936

CARRYING VALUE OF PLANT, SEPTEMBER 1, 1935.....		\$1,018,550.09
ADDITIONS DURING 1935-36:		
1. Expended from Plant Funds (None).....	\$	.00
2. Expended from Current General Funds.....		42,257.36
3. Expended from Current Restricted Funds.....		127.00
Total Current General and Current Restricted Funds (Schedule B-2).....		42,384.36
4. Expended from Revolving Funds (Schedule B-4).....		11,056.16
5. Expended from Feed Control Service Funds (Exhibit G).....		2,478.72
6. Adjustments to previously reported values (Schedule E-2 & 3).....		7,626.68
Total Additions.....		63,545.92
Carrying Value of Plant, September 1, 1935, plus additions.....		\$1,082,096.01
DEDUCT:		
1. Sale of Equipment (Schedule E-3).....		8,182.58
2. Plant Assets worn out, discarded, etc. (Schedule E-2 & 3).....		10,211.15
Total Deductions.....		18,393.73
VALUE OF PLANT, August 31, 1936 (To Exhibit A).....		\$1,063,702.28
Value of Plant at August 31, 1936		
Made up as follows:		
Land.....		\$ 269,221.10
Buildings.....	\$	379,917.67
Improvements Other Than Buildings.....		35,021.58
Total Buildings and Other Improvements.....		414,939.25
Equipment.....		379,541.93
Total (To Exhibit A).....		\$1,063,702.28

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE E-1

Summary Statement of Inventory Valuation

At August 31, 1936

Main Station		
Administrative.....	\$	39,828.51
Veterinary Science.....		30,884.28
Horticulture.....		18,099.56
Range Animal Husbandry.....		26,340.95
Entomology.....		16,370.28
Apiculture.....		17,129.65
Agronomy.....		17,793.91
Main Station Farm.....		44,560.56
Plant Pathology and Physiology.....		7,433.65
Soil Survey.....		1,788.56
Farm and Ranch Economics.....		6,050.56
Publications.....		43,943.48
Botany.....		2,517.97
Loco Weed Research Laboratory.....		3,347.57
Chemistry.....		35,250.65
Photographic Laboratory.....		4,545.00
Rural Home Research.....		16,230.66
Agricultural Engineering.....		6,753.46
Feed Control Service.....		5,173.88
Total Main Station.....	\$	344,043.14
Substations		
No. 1 Beeville.....		21,219.45
No. 2 Tyler.....		34,998.43
No. 3 Angleton.....		25,650.07
Plant Lice Laboratory.....		4,237.74
No. 4 Beaumont.....		36,556.81
No. 5 Temple.....		55,917.59
No. 6 Denton.....		31,327.76
No. 7 Spur.....		61,364.12
No. 8 Lubbock.....		33,727.55
No. 9 Balmorhea.....		30,983.87
No. 10 College Station (Feeding and Breeding Station).....		42,968.72
Division of Dairy Husbandry.....		23,643.46
Division of Swine Husbandry.....		18,991.31
Division of Poultry Husbandry.....		17,620.70
No. 11 Nacogdoches.....		37,015.67
No. 12 Chillicothe.....		32,288.99
No. 14 Sonora.....		151,868.48
No. 15 Weslaco (Lower Rio Grande).....		119,095.47
No. 16 Iowa Park (Wichita Valley).....		30,796.22
No. 19 Winter Haven.....		36,519.97
Total Substations.....	\$	846,792.38
Total Inventory Valuation.....		\$1,190,835.52
Consisting of:		
Supplies and Crops Inventories.....	\$	127,133.24
Invested in Plant.....		1,063,702.28
Total.....	\$	1,190,835.52

EXHIBIT F

Transactions of the Feed Control Service
 For the Fiscal Year Ended August 31, 1936

INCOME		
Tag Sales.....	\$ 121,079.03	
Total Income.....		\$ 121,079.03
EXPENDITURES		
Salaries and Wages		
Administrative Salaries.....	9,225.00	
Instruction and Research Salaries.....	31,802.40	
Clerical and Stenographic Salaries.....	11,910.00	
Other Salaries.....	1,643.04	
Wages.....	7,942.49	62,522.93
Consumable Supplies		
Postage, Stationery and Office Supplies.....	2,224.10	
Laboratory Supplies.....	1,215.67	
Fuel.....	.00	
Feeding Supplies.....	7,444.81	
Tags (Purchased).....	20,224.41	
Other Consumable Supplies.....	152.79	31,261.78
Expense		
Telegraph and Telephone.....	299.95	
Travel.....	10,634.11	
Transportation of Things (Service).....	47.57	
Publications.....	5,760.31	
Heat, Light, Power, Water and Gas.....	2,590.79	
Other Current Expenses (Including Chemical Analysis).....	18,024.25	
Refunds.....	331.16	37,688.14
Repairs and Alterations		
Repairs to Buildings.....	584.82	
Other Repairs.....	253.69	838.51
Total Salaries and Wages Plus Operating Expenses.....		\$ 132,311.36

EXHIBIT F—(Continued)

Transactions of the Feed Control Service
For the Fiscal Year Ended August 31, 1936

Equipment		
Main Office		
Furniture and Office Equipment.....	\$	325.14
Books.....		2.00
Other Equipment.....		30.85
Total Main Office.....	\$	357.99
Other Divisions and Substations		
Chemistry		
Furniture and Office Equipment.....		86.86
Scientific Apparatus.....		840.23
Total Chemistry.....		(927.09)
Agronomy		
Scientific Apparatus.....		36.00
Publications		
Furniture and Office Equipment.....		89.10
Books.....		107.35
Other Equipment.....		26.24
Total Publications.....		(222.69)
Swine		
Scientific Apparatus.....		722.27
Poultry		
Other Equipment.....		34.53
Lufkin		
Tools, Machinery and Motor Vehicles.....		126.15
Other Equipment.....		52.00
Total Lufkin.....		(178.15)
Total Other Divisions and Substations.....		2,120.73
Total Equipment.....	\$	2,478.72
Total Expenditures.....	\$	134,790.08
Excess Expenditures over Current Year's Income.....		13,711.05
Total Expenditures From Current Year's Income.....	\$	121,079.03

